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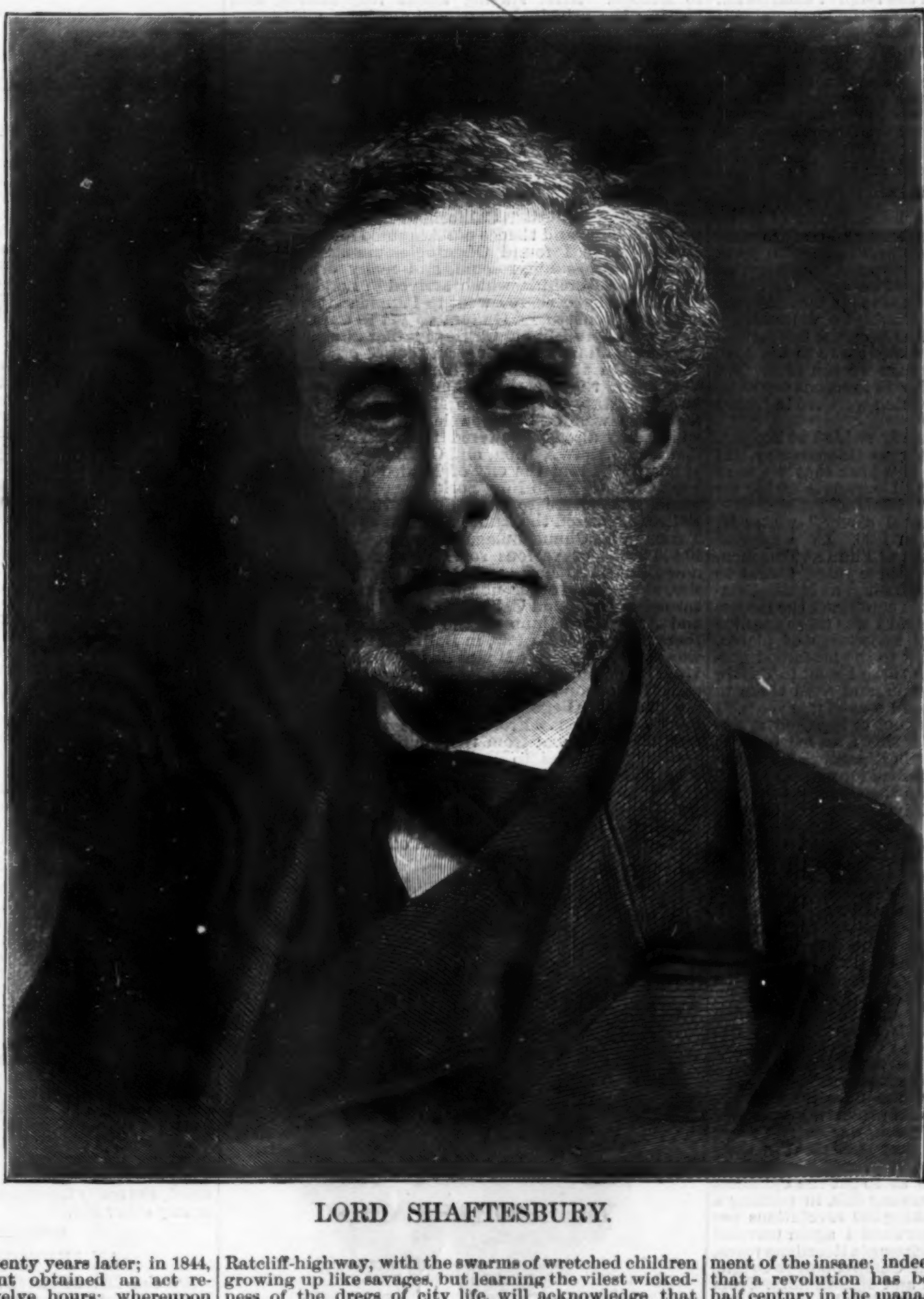
THE LATE LORD SHAFTESBURY.

THE death, on Oct. 1, 1885, in his eighty-fifth year, of this venerable, faithful, and most useful laborer for the improvement of the condition of the poor, has deeply moved the heart of the English people. In London, more especially, and in the manufacturing districts, his work both as a legislator and as a personal superintendent of benevolent agencies has been productive of much good. The voices of praise and gratitude have been raised in honor of Lord Shaftesbury by the spontaneous feeling of the humbler classes, as well as by the testimony of those clergymen, dissenting ministers, and laymen devoted to efforts of Christian charity, who recognized in him one of the most influential patrons of moral and social reform. Neither differences of religious creed nor of political opinion, though he was addicted to strong partisanship with reference to the former, and sometimes used language that savored little of wisdom and gentleness in his condemnation of theological error, have prevented men of all sects and parties joining in the common tribute of esteem.

The seventh Earl of Shaftesbury, Anthony Ashley Cooper, now deceased, was born April 28, 1801, the son of the sixth Earl by a daughter of the third Duke of Marlborough, and was known as Lord Ashley till his father's death, in 1851. He was educated at Christ Church, Oxford, where he was first-class in classics, and was elected M.P. for Woodstock in 1826. He sat in the House of Commons, afterward, for Dorchester, for the County of Dorset, and for Bath, until he was called to the House of Lords. In politics, he was attached first to Canning, afterward to the Duke of Wellington and Sir Robert Peel, and subsequently to Lord Palmerston; but he never seemed a zealous champion of either of the rival parties in the state. He held subordinate ministerial offices, for a few months, at the Board of Control in 1830, and at the Admiralty in 1834, but soon came to bestow his chief attention upon special objects of philanthropy. The first of these was that of the better regulation of labor in the cotton factories of Lancashire and Yorkshire, which he took over from Mr. M. T. Sadler and Richard Oastler in 1833. The employment of children in the factories was at that time attended with cruel abuses, to restrain which Lord Ashley brought forward a bill, long and obstinately resisted in Parliament, but destined to be the foundation of many other legislative acts for the protection of work-people. The question was still being agitated, in different shapes, ten and even twenty years later; in 1844, Sir Robert Peel's Government obtained an act restricting factory labor to twelve hours; whereupon Lord Ashley and Mr. John Fielden, of Todmorden, went forward with the ten hours' movement, which gained a victory in 1847; but Lord Palmerston, being Home Secretary in 1853, completed the reform by an act limiting the employment of children to daylight hours. A subject of kindred interest, the employment of women and children underground in collieries and other mines, which was then practiced in a manner still more cruel and disgusting, occupied Lord Ashley from 1840 to 1842, with a more expeditious victory by the law passed in the latter year; and his earnest advocacy of the cause of humanity, upon all these occasions, won him the hearty gratitude of millions of the English people in the mining and manufacturing districts.

The second great object of his public life, and that which has rendered the name of Lord Shaftesbury most familiar to Londoners, was pursued by him from 1846 with extraordinary diligence to the end of his active career. This was the work of reclaiming from vice and crime the neglected poor boys of the London streets, placing them under moral and industrial discipline, and helping them to an honest and useful life. Along with this, Lord Shaftesbury earnestly promoted the work of the London City Mission, and other agencies for diffusing evangelical religion among the people; and he was one of the first patrons of building improved habitations for the families of the poor. Those who can remember the state of London forty years ago, the scenes of squalid misery in the neighborhood of St. Giles's, Drury-lane, and Field-lane, in some parts of Marylebone, in the Borough, and about Ratcliff-highway, with the swarms of wretched children growing up like savages, but learning the vilest wickedness of the dregs of city life, will acknowledge that Lord Shaftesbury's work for their benefit was sorely needed. It has been more his work than that of any other individual, though hundreds of volunteer fellow-workers, besides the official ministers of religion, have toiled indefatigably in all the districts where it was most required. The Ragged School Union, of which he was President from 1844, had by 1883 gathered from the streets 300,000 boys and girls, "all of whom," he said, "if they had not been taken up, would have been found among the dangerous classes." In many of the stories and sketches written by Charles Dickens, from "Oliver Twist" to "Bleak House," readers of a later day will find pictures, scarcely exaggerated, of the condition of low London life, and its effect upon the morals and manners of the young. Lord Shaftesbury, by his well-managed institutions, which he would personally visit in the most distant and disagreeable quarters, and where his presence was hailed as that of a friend, adviser, and instructor—by his "Ragged Schools," his "Shoeblack Brigade," his "Reformatories," and "Refuges," and other agencies of reclamation—helped to save tens of thousands of juvenile truants and beggars from becoming habitual criminals, and to deliver society from a very great peril. The Lord Mayor of London, Sir Robert Fowler, in his sermon preached at the Holborn City Temple last Sunday, might well bear witness to the services which this great Christian philanthropist has actually rendered to London. With all the magistracy and police, we should not be so tolerably safe as we are, in this enormous city, if the "street Arabs" had been left, as Lord Shaftesbury used to say, to be "brought up by the Devil." It was by his influence with the Government of the day, and as a member of the House of Lords, that legislative measures to check "Juvenile Mendicancy" and "Juvenile Delinquency" were undertaken and carried; but Mr. Adderley, now Lord Norton, is also entitled to much of the credit. Power was given to courts of criminal jurisdiction to send juvenile thieves and other offenders to the Reformatory Schools, of which those established by philanthropic efforts in various parts of the kingdom were distinctly recognized by the Government, and received aid from the national funds. The Reformatory and Refuge Union, established by Lord Shaftesbury, has now 589 schools, with accommodation for nearly fifty thousand inmates. Sanitary reform and the health of the people were also the objects of his solicitude. In his speech on the Public Health Bill in 1848, he called attention to these questions, and on one occasion, in addressing the House of Lords, he affirmed that the overcrowding of our towns and the condition of the dwellings of the people lay at the root of two-thirds of the disorders which afflicted the country. He held that good drainage, good ventilation, good and healthy houses, and an ample supply of good water would not only go far to extinguish epidemics and reduce fevers, but would have a great influence upon the moral habits of the population. Lodging house reform was another matter in which he rendered essential service, and among the measures passed by the legislature at his instigation was a very necessary one for the registration and inspection of common lodging houses.



LORD SHAFTESBURY.

When the lunacy laws of the country were in a disgraceful condition, Lord Shaftesbury took the initiative in amending these laws, and for upward of fifty years he was chairman of the Lunacy Commissioners. Great reforms were effected in the treatment of the insane; indeed, it is no exaggeration to say that a revolution has been witnessed during the past half century in the management of public and private asylums. In addition to these and other labors of social reform, Lord Shaftesbury, as is well known, frequently presided at the annual meetings of various religious societies, at Exeter Hall and elsewhere; promoted the holding of Sunday services, for divine worship and preaching, in the London theaters and public halls; took part in the debates of the House of Lords upon questions affecting the Church, and was for some years, till 1847, in the Ecclesiastical Commission.

On his estate at Wimborne St. Giles, in Dorsetshire, the laborers' cottages were rebuilt with every convenience, and allotment grounds were given to each inhabitant. His Lordship was President of the following charities: The Children's Aid and Refuge Society, Field-lane Ragged Schools, Flower Girls' Mission, Foxcourt Ragged School, Hospital for Sick Children, Great Ormond Street; Hospital for Women, Soho Square; Indigent Blind Visiting Society, London Orphan Asy-

lum, Ragged School Union, Reformatory and Refuge Union, Royal Hospital for Diseases of the Chest, Royal Orthopædic Hospital, Oxford Street; Society for Improving the Condition of the Laboring Classes, and the Surgical Aid Society. The charities of which he was the vice-president are the Chelsea Hospital for Women, City of London Hospital for Diseases of the Chest, Finsbury Dispensary, Society of Friends of Foreigners in Distress, General Domestic Servants' Benevolent Institution, the German Hospital, London Aged Christian Society, London Female Penitentiary, Metropolitan and National Nursing Association, Metropolitan Convalescent Institution, Middlesex Hospital, National Hospital for Heart Disease; Philanthropic Society, Redhill; Protestant Blind Pension Society, Royal Hospital for Women and Children, the Royal Maternity Charity, and the Royal Medical Benevolent College. Several charities also claimed Lord Shaftesbury either as patron or vice-patron. Among the former are the Christian Blind Relief Society, Governesses' Benevolent Institution, Infirmary for Consumption, Margaret Street, Cavendish Square; and the "One Tun" Ragged School and Mission; and among the latter are the British Orphan Asylum, Cab-drivers' Benevolent Association, Charing-cross Hospital, and the London Society for Teaching the Blind to Read.

The late Earl married, in 1830, Lady Emily Cowper, daughter of the fifth Earl Cowper and of Countess Cowper, afterward Lady Palmerston. Lady Shaftesbury died in 1872, leaving several children, the eldest of whom, Lord Ashley, formerly M.P. for Hull and for Cricklade, now succeeds to the earldom; Mr. Evelyn Ashley, M.P., is his younger brother. The peerage was created in 1672, the first Earl being Anthony Ashley Cooper, Lord Chancellor in the reign of Charles II., the friend of John Locke, and one of the most eminent statesmen of the Restoration period.

The body of Lord Shaftesbury was this week brought from Folkestone, where he died, to his London house in Grosvenor Square, and on Thursday a public funeral service over it was performed in Westminster Abbey, after which it was conveyed to Dorsetshire for interment at Wimborne St. Giles.—*Illustrated London News.*

BENEDICT ROEZL.

ALL those interested in the introduction of interesting plants, indeed all those who sympathize with courage, energy, and intelligence, will learn with great regret of the death of this renowned collector, at Prague, in the sixty-second year of his age.

He was born in Bohemia, and began his horticultural career when he was twelve years old. To write an account of his wanderings and adventures (he was robbed seventeen times), to detail all that we owe to his zeal, would demand far more space than we can give. We have therefore judged it best simply to repeat the summary biographical notice for which we were indebted to him some ten years ago.

Since that time Roezl has chiefly resided at Prague, but was not an infrequent visitor to this country. It was as late as the summer of this year that we were privileged to see him, and avail ourselves of his experience.

"I started in my horticultural career," writes M. Roezl, "in my thirteenth year, in 1836. I was apprenticed in the gardens of the Count of Thun at Totschen, in Bohemia, from which, after three years, I went to the gardens of the Count Paulikowsky, at Medica, Galicia. At that time these gardens contained the largest collection of plants in Europe, and I was there enabled to gain most of my botanical knowledge of plants. After staying three years I went to the far-famed gardens of Baron Von Hugel; from there I went to Telsch, in Moravia, to Count Lichtenstein, and from there to Ghent, to M. Van Houtte, where I stayed five years. I was *chef de culture* in the School of Horticulture of the Belgian Government. After this I served for two years as foreman to M. Wagner in Riga (Russia). From Riga I went again to M. Van Houtte for two years, but I could no longer restrain my ardent wish to see the tropics, and I proceeded *via* New Orleans to Mexico—this was in 1854. In Mexico I started a nursery for European fruit trees; there also I collected a large number of Mexican Pines. From thence I sent to Europe Dahlia imperialis, Bouvardia Humboldtii, Zinnia Haageana, Cosmos atropurpureus, Agave schidigera, and many other plants. I introduced into Mexico the culture of the Ramie (Bohmeria tenaceissima), and planted many acres of land with it. I invented also a machine for extracting and cleansing the fiber of ramie and hemp, and took out a patent for my machine from the Government of the United States on September 17, 1867. The Agricultural Exhibition awarded a diploma for it in February, 1868. This discovery was the cause in 1868 of the loss of one of my arms. Many people in Havana solicited me to exhibit my machine there, and I was asked by some gentlemen to try if the machine would extract the fiber from Agave Americana. The result of the trial proved my assertion, that the fiber would come out green, was correct; but in endeavoring to show that they were right in their assertions, they managed in some way or the other to fasten some screws tighter, so as to get the cylinders closer together, and I, not knowing this, in putting a leaf between the cylinders (making 360 revolutions per minute) lost my left arm. Afterward I again traveled in Mexico, and discovered Dalechampia Roezliana rosea, Aphelandra aurantiaca Roezlii, Campyobotrys Ortgiesii, C. Roezlii, Nægelia fulgida and digitali-flora. From Mexico I went again to Havana and Cuba, and discovered Microcycas species.

"Afterward I proceeded to New York, to start on my Californian travels over the Rocky Mountains and Sierra Nevada. I discovered here the new lilies Washingtonianum, puberulum, parvum, and Humboldtii; the latter I found on the hundredth memorial day of Alexander Von Humboldt, and hence named one of the species after him. The lily in question does not come from the Humboldt country, as some catalogues assert. I also found here Saxifraga peltata, Calochortus Leichtlinii, Abies magnifica, and many others that have been published from time to time. From there I went to Panama and Ocana, in New Granada, where I found Utricularia montana, Anæctochilus Ortgiesii, and forwarded about 10,000,000 orchids to Europe, and something like 500 species of plants. From there I went to Sierra Nevada from Santa Martha; I found there Telepogon Roezlii (Reich.), and of which I collected 800 plants. These died in one night, owing to the great heat in Rio de Hatcha. I also found many new varieties of Odontoglossum, and forwarded upward of 3,000 to Europe.

"Then at the beginning of the Franco-German war I went to Panama and San Francisco, and owing to the war many of my assignments arrived dead at their destination. Wishing to await the end of the war, I went to the Washington Territory and found Lilium columbianum, and a great variety of Conifer seeds. From there I proceeded to Sierra Nevada, California, to gather Conifer seeds, but the harvest was lost on account of the severe frost. From there I went to South California, then to Panama and Bonaventura, in Choco; here I found Gaura Roezlii, and Lindeni, and Cypripedium palmifolium and Roezlii. Here I also gathered Cattleya chocoensis, and brought them to Bonaventura to ship them, and returned through the valley of Cauca. Now a very difficult journey commenced through the State of Cauca to Antioquia, where I discovered large quantities of many varieties of Masdevallias, described by Professor Reichenbach, and Odontoglossum vexillarium, Curmeria picturata, Cattleya gigas, Phyllotænium Lindeni, and many Dieffenbachias and other Aroids. After a journey of six months, I traveled down the Magdalena River, and to Colon and Panama, thence to North Peru, crossed the Andes, where I found a scarlet violet, a new specimen of heliotrope, Tillandsia argentea, Epidendrum Frederici Guilielmi, Masdevallia amabilis, etc. I returned to Payta to ship my plants and myself too, and went to Bonaventura, found Odontoglossum Roezlii, and when almost exhausted I found on the way Masdevallia chimæra, and several new Aroids, which I brought myself to Europe. After staying about four months and visiting the principal towns and nurseries, and seeing my parents again, I started once more for a new series of travels.

"On August 3, 1872, I went from Liverpool *via* New York into the Colorado Territory, and in Denver City I was robbed of 2,000 dollars, the whole of my possessions. There I collected Yucca angustifolia, Calochortus Krelagii, Ipomœa leptophylla, and proceeding to New Mexico found the beautiful Abies concolor (Engelmann), Yucca baccata, many hardy Cacti, and many annuals and perennials. From there I went again to the Sierra Nevada, where I found Pinus edulis, P. Bolanderi, and collected Californian Lilies, and went to San Francisco and thence *via* Acapulco into the Sierra Madra, where I found Odontoglossum maxillare pulchellum, citrosmum, roseum, and many others—altogether 3,500 orchids, which arrived in London in fine condition. From there I went to Panama over the Isthmus, and went to La Guayra to get to Caracas in Venezuela, where I found Cattleya labiata Roezlii. I forwarded in all no less than eight tons of orchids to London. From there to St. Thomas and to Havana and Vera Cruz, then to the Isthmus of Tehuantepec and into the State of Oajaca, in Mexico, where I found a real "new wonder," the double Poinsettia pulcherrima, which has already flowered in New York, and many Cacti and Agaves, Dion, and Orchids—in all ten tons of plants. From the city of Mexico I returned from Vera Cruz to go to New York, from New York to Panama, from there to Lima and Peru, over the Oroza Railroad, crossed the Andes at a height of 17,000 feet to Tarma and Chanchamaga, brought back with me 10,000 bulbs of various sorts, Pilocereus mollis, many new Bromelias, Loasas, Calceolarias, Fuchsias, Mutisias, and many other new plants. From thence I returned to Lima and Callao to South Peru, to Morienda and Arigipa, to Puno on the Lake of Titicaca. From there I went to La Paz, in Bolivia, and from thence I went over the Snowy Mountains of Illimani to the province of Yungas; there I found Odontoglossum selligerum, Telepogon Benedicti, Masdevallia aspera, many new bulbous Begonias, Loasas, Tacsonias, Tropæolums, and others. From thence I returned to Tacna and Arica to Lima; from there again I went to Payta, crossed the Andes to Huaca-Camba, from whence I sent home many Masdevallias and Odontoglossums, Pilocereus Peacockii, and Telepogon Hercules, and went to Guayaquil (Ecuador). From there down the Chimbazo, found the Zamia Pescatorea Roezlii (Rchb.), Batemanni, Wallisii (Rchb.), and others. I returned to

BENEDICT ROEZL.

Guayaquil, and went to Bonaventura to visit once more the Valley of Cauca, where I found Masdevallia chimæra, Odontoglossum Roezlii, Pescatorea Dayana, and many others. With these I started once more for London.

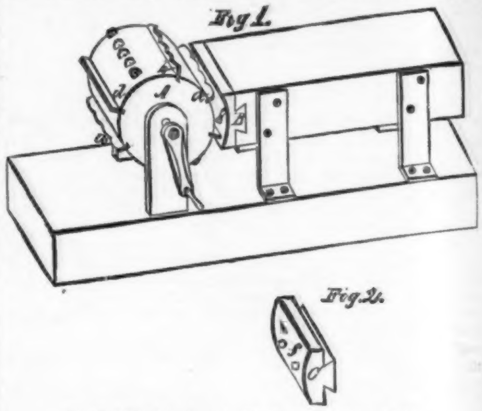
Such, in mere outline, is the account of M. Roezl's wanderings, and of the results of his travels, as given in the *Gardeners' Chronicle.*

We add a drawing and description of his machine for extracting hemp and ramie fiber, as given in his U. S. patent of 1867.

ROEZL'S MACHINE FOR CLEANING HEMP, RAMIE, ETC.

Figure 1 is a perspective view of my machine as when ready for the first operation in my process, and Figure 2 a detached view of a certain alternate part of my machine.

My machine consists of a metallic cylinder of thirty-six inches in diameter, more or less, and eighteen inches, more or less, in length, which is driven by any suitable machinery or motive power, when the machine is in operation, at the rate of from three to four hundred revolutions a minute. This cylinder is provided with transverse bars or knives of metal at four inches distance from one another, and projecting or rising half an inch from the perimeter of the same. The knives are of four descriptions, and they are placed alternately or in such manner that no two of the same kind are next each other. The shape and arrangement of the knives may be clearly seen at *a*, *b*, *c*, *d*, Fig. 1.



B. ROEZL'S RAMIE MACHINE, 1867.

Another part of my machine is a table edge, that is placed a little distance from the ends or points of the knives, which is faced or covered by a thin metallic plate, as shown at *e* upon the drawings. As the plants to be freed of their gum, wood, etc., undergo two distinct operations, there must be two machines, or the equivalent of two machines, in one of which the metallic edge must be concave and in the other convex. I construct my table in such manner that the metal-covered edge is adjustable and removable, so that either the concave or the convex form can be used at the pleasure of the operator, and hence my machine performs the work of two machines. The table edges, although removable and adjustable whenever it is necessary to substitute one for the other, or to reduce or increase the open space between them and the cylinder, are yet immovable when the machine is in operation, and herein my machine differs from all others designed to accomplish a similar object of which I have any knowledge, including Sandford's and Mallory's machines, as patented in 1862, for in all other machines a yielding or elastic table edge or surface is used for holding the plants to the action of the knives.

Upon the drawings the cylinder is marked A, the alternate series of knives *a b c d*, the concave table edge B, the convex edge C, and the metallic facing of the table edges *e* and *f*. The cylinder may be of the form shown on the drawings, or it may consist of a hollow drum with open ends; but in any and all forms that may be adopted it must always have a closed circumferential surface or perimeter.

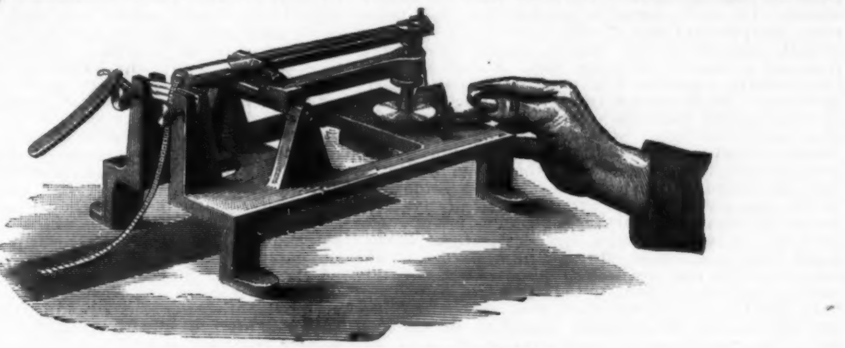
I proceed now to describe the process by which I reduce the plants to a fit condition for use and the operation of my machine.

The hemp or like plants freshly pulled, and the ramie or like plants freshly cut, the roots remaining in the ground, the operator takes a handful of them in his right hand, grasping them two feet or thereabouts from the lower end, and motion being given to the cylinder, he presents them against the knives across the metal-covered edge of the table, when the action of the knives strips off the leaves, scrapes away the bark, and takes out the woody substance and three-fourths of the resinous or gummy matter, the rubbish falling upon the ground and the fiber being unhurt. The operator then subjects the other end of the plants in the same way to the operation of the knives, with a like result as above, and the plants are thus cleaned throughout their whole length. This first operation is performed with the concave edge adjusted upon the table. The operator then takes six skeins or hanks of fiber thus prepared, and uniting them places them in water to steep and decompose or soften the remaining one-fourth of the gum. This mass of fibers, after being thoroughly saturated, is again subjected to the action of the machine, the concave table edge having been removed, and the convex edge substituted in its stead. The effect of this second operation is to make the fibers quite soft and white, and to spread them out like cloth. They are next placed in a solution of common lye soap and water, heated nearly but not quite to the boiling point, in which they are permitted to remain a few hours. They are then withdrawn from the solution, and, being dried, are ready for manufacture, packing for shipment, or any other use.

AN IMPROVED MICROTOME.

AT the Inventions Exhibition, London, the Cambridge Scientific Instrument Company exhibit a rocking microtome, of which we give an illustration from *Engineering.* This is used for cutting thin sections for microscopical purposes, the objects being embedded in paraffin wax. The two uprights cast on the base-plate, as shown, are provided with slots at the top, into which the razor that cuts the sections is placed, being then clamped by two screws with milled heads. The inner face of the slot is so made as to give the razor that inclination which has in practice been found most advantageous. The embedded object is cemented with paraffin into a brass tube, which fits tightly on to the end of a cast-iron lever. This tube can be made to slide backward and forward, so as to bring the embedded object near to the razor for adjustment. The cast-iron lever is pivoted at about 3 in. from the end of the tube, and to the other end of the lever a cord is attached, by which the necessary cutting motion is given. The bearings of the trunnions of

pivot, on which the lever works, are V-shaped grooves forming themselves part of another pivoted system. Immediately under them is another pair of V bearings resting on a rod fixed to the two standards cast on the baseplate. A horizontal arm projects from the block in which the two sets of V bearings are, and on the end of this arm is a boss with a hole in it, the bearings, arm, and boss forming one casting as shown. Through the hole in the boss a screw passes freely, but the bottom of the boss is turned spherically, and fits on to a spherical nut working on the screw. The nut is prevented from turning when the screw is turned, by a pin which passes through a slotted hole in the boss, and in this way when the screw is turned the arm is raised or lowered at its outer end. It will be seen that when the end of the lever is raised, the object to be cut is moved forward in consequence of the top V bearings being higher than the lower ones. The distance of these two apart is 1 in., and the distance of the screw from the fixed rod is 6¼ in. The thread of the screw is pitched twenty-five turns to the inch, so that, if one turn be taken, the object to be cut will be moved forward $\frac{1}{156}$ in. The turning of the screw is effected by a ratchet movement. The lever is moved backward and forward between two stops, but the amount the wheel is turned is varied by an adjustable sector, which engages a pin fixed to the pawl, preventing the latter from taking into the teeth of the wheel. By adjusting the position of this sector the feed can be varied from nothing to about $\frac{5}{16}$ of a turn. The minimum thickness of the sections cut depends on the perfection with which the razor is sharpened; with a good razor, it is approximately $\frac{1}{4000}$ in.



CALDWELL'S IMPROVED MICROTOME.

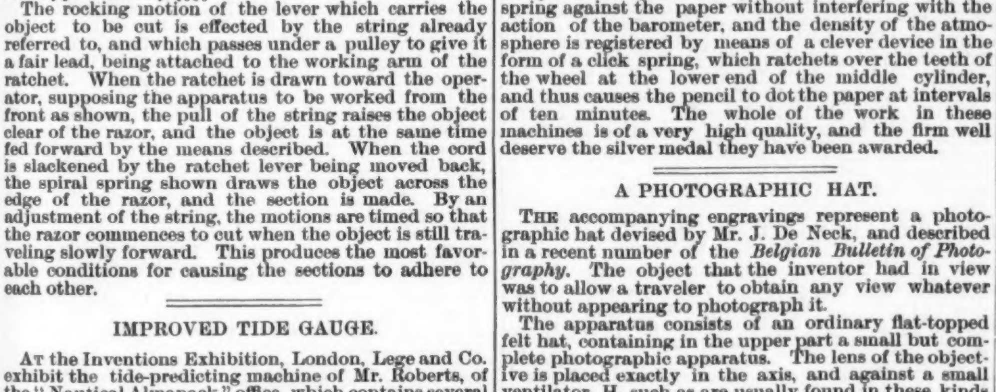
The rocking motion of the lever which carries the object to be cut is effected by the string already referred to, and which passes under a pulley to give it a fair lead, being attached to the working arm of the ratchet. When the ratchet is drawn toward the operator, supposing the apparatus to be worked from the front as shown, the pull of the string raises the object clear of the razor, and the object is at the same time fed forward by the means described. When the cord is slackened by the ratchet lever being moved back, the spiral spring shown draws the object across the edge of the razor, and the section is made. By an adjustment of the string, the motions are timed so that the razor commences to cut when the object is still traveling slowly forward. This produces the most favorable conditions for causing the sections to adhere to each other.

IMPROVED TIDE GAUGE.

At the Inventions Exhibition, London, Lege and Co. exhibit the tide-predicting machine of Mr. Roberts, of the "Nautical Almanack" office, which contains several new and interesting features. The middle cylinder, or drum, is turned by clockwork, and is geared at the bottom through an intermediate wheel with the left hand cylinder, upon which the paper as it is marked is rolled; and as this second cylinder, through the agency of the mechanism, is always made to travel a little faster than the first, the paper is kept tight. The right hand cylinder carries the roll of paper, and is in its turn regulated by means of a friction spring at its lower end. The middle cylinder turns once in 24 hours, each of which is indicated by a pin, which pricks through the paper, and obviates the necessity for the use of the usual ruled or squared paper. The paper is marked by a pencil, which is pressed against it by a spring, the movement of which up and down the graduated scale is governed by the raising and lowering of the float. The float acts on the mechanism through a copper band or ribbon running on pulleys, the top one of which is geared to the wheels at the top of the frame.

The counterpoise to the float shown at the right of the stand has a cord running over a grooved truncated cone, or fusee, by means of which the difference in weight of the copper band is equalized, and the float balanced.

The force and direction of the wind are also registered through the agency of an anemometer and dart attached to this machine—not shown in the cut—the pencils and indices registering and recording each being fitted to the lower part of the scale, and marking the paper in the same manner as the tide register; and a barometer is attached, the self-registering attachment of which is a very ingenious contrivance. The delicacy of the movement of the mercury would not permit of a pencil being kept closely pressed by a spring against the paper without interfering with the action of the barometer, and the density of the atmosphere is registered by means of a clever device in the form of a click spring, which ratchets over the teeth of the wheel at the lower end of the middle cylinder, and thus causes the pencil to dot the paper at intervals of ten minutes. The whole of the work in these machines is of a very high quality, and the firm well deserve the silver medal they have been awarded.



INVENTIONS EXHIBITION.—MESSRS. LEGE & CO.'S TIDE GAUGE.

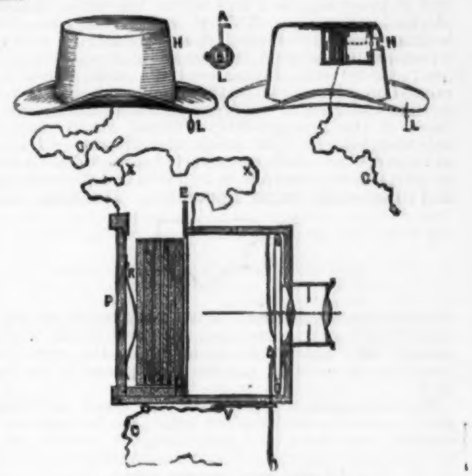
A PHOTOGRAPHIC HAT.

The accompanying engravings represent a photographic hat devised by Mr. J. De Neck, and described in a recent number of the *Belgian Bulletin of Photography.* The object that the inventor had in view was to allow a traveler to obtain any view whatever without appearing to photograph it.

The apparatus consists of an ordinary flat-topped felt hat, containing in the upper part a small but complete photographic apparatus. The lens of the objective is placed exactly in the axis, and against a small ventilator, H, such as are usually found in these kinds of hats. To the brim of the hat is attached (by means of a little slide, A) an eye-glass, L, whose glass is black with the exception of a central square, B, which performs the office of an iconometer, and shows the image reproduced at the same moment in the apparatus. The cord, C, attached to the bolt, V, permits of maneuvering the instantaneous shutter, D. As the objective has a fixed focus, the ground glass of the ordinary apparatus is done away with, and the sensitized plates are placed in a frame forming part of the apparatus.

The plates, each held in a very light, thin copper frame, are introduced through the door, P, and are brought to focus through the pressure of the spring, R.

After exposure, each plate is raised, by means of the extractor, E, into the pocket, X (which is made of a fabric impermeable to light), and introduced between the spring, R, and the other plate that the frame contains.



A PHOTOGRAPHIC HAT.

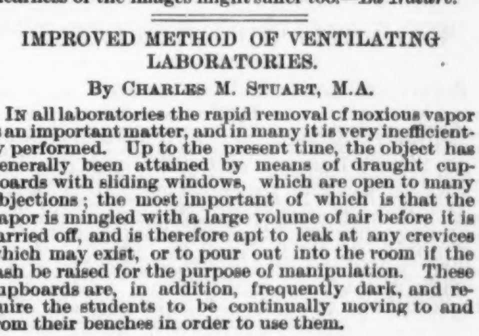
The entire affair is held in place by a small slide fixed to a piece of wood that is fastened to the crown of the hat. Through this arrangement, it is easy, after the photograph has been taken, to remove the apparatus and put it and the eye-glass into one's pocket.

The little negatives (0·18 × 0·18 inch) taken with the photographic hat permit of projecting very sharp views five feet square by means of the oxyhydrogen lantern. The small gelatino-bromide plates might be replaced by one of the new systems of preparations for pellicular negatives that have recently been introduced; but this would slightly increase the weight, and perhaps the clearness of the images might suffer too.—*La Nature.*

IMPROVED METHOD OF VENTILATING LABORATORIES.

By CHARLES M. STUART, M.A.

In all laboratories the rapid removal of noxious vapor is an important matter, and in many it is very inefficiently performed. Up to the present time, the object has generally been attained by means of draught cupboards with sliding windows, which are open to many objections; the most important of which is that the vapor is mingled with a large volume of air before it is carried off, and is therefore apt to leak at any crevices which may exist, or to pour out into the room if the sash be raised for the purpose of manipulation. These cupboards are, in addition, frequently dark, and require the students to be continually moving to and from their benches in order to use them.



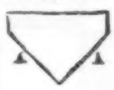
The essentials of good ventilation are that a noxious vapor may be carried away at once, and that the vessel emitting it shall be capable of manipulation without the vapor escaping into the laboratory. In some laboratories recently constructed, the improvement has been made of giving each student a draught on his own bench. Such an arrangement exists at Nottingham University College, and is described by Professor Clowes in the new edition of his "Practical Chemistry," a funnel-shaped copper hood, connected with a system of draught pipes, being placed over the vessel emitting vapor. I am informed, however, by Prof. Clowes that he regards this arrangement as unsatisfactory, because acid fumes attack the copper, and drops of liquid containing copper fall into the vessel in question: the putting up and removing the hood for every operation also involves trouble.

In the *Berlin Berichte*, 18, 1436, an arrangement is described, in which a small slit is made in the chimney itself, over which a glass plate projects, and the liquid to be evaporated is placed under the glass plate. I thought that if this arrangement could be modified so as to be placed on every student's bench, the desired end would be obtained, and I have found the following arrangement work so extremely well that I have thought it worth describing here.

The draught is caused by a square chimney, 1 ft. in the side, heated by a ring burner; from the bottom of this a pipe is led under the floor of the laboratory, where it divides and subdivides into as many branches as are required. Each branch ends in a 4 in. pipe, which is brought up at the back of the student's bench.

Over the opening of the pipe is placed a wooden box, 18 in. to 2 ft. in height, and of the same internal diameter as the pipe, closed on all sides and on the top. In the front of this, at a convenient height from the table, a slit is cut, which can be closed by a wooden slide, capable of being readily pulled out by means of a knob. On each side of the slit is a piece of wood of the shape of a right-angled triangle, supporting a sheet of glass over the slit at an angle of 30° with the horizontal. The dish containing the acid to be evaporated or boiled is placed under the glass and the slit opened; the vapor is carried at once into the system of draught-pipes, and the evaporation proceeds faster because it is conducted in a current of air.

The dimensions I have found useful for ordinary analytical work are as follows: The slit is 2 in. wide, and its lower edge is 1 foot above the table; the sheet of glass is 6 × 8 in. This is a convenient height for boiling test-tubes or small flasks containing acid over a burner; but as most frequently noxious vapors are produced by evaporating acid in a dish, a shelf is arranged on a hinge two or three inches above the table, so that when not in use it can be folded flat against the front of the draught-box; a tripod stand placed on this shelf brings a dish close under the slit. Of course, in laboratories where more varied work is done it would be advisable to have one or two slits of different heights and sizes to suit larger apparatus. The figure shows



the whole arrangement. Most of the boxes are square in section, but in some cases, where students working side by side had to be provided for, the boxes were made thus in section, and the slits placed in the faces, A A.

This arrangement possesses the great advantages that it contains nothing but what can be made by an ordinary carpenter, and that the glass permits one to see the condition of the liquid undergoing evaporation. In my own laboratory there are eight draught pipes, and as five of them are double, this gives thirteen holes at which liquids may be evaporated. When all of these are open, the draught is not so good, but still it is satisfactory; but when, as is nearly always the case, only five or six are open together, the draught is excellent, and the glass can be removed and the liquid manipulated without any vapor escaping into the room.

This system has been for some time in use in my laboratory at the High School, Newcastle-under-Lyme, and I can thoroughly recommend it to the notice of any chemist who is interested in the subject.—*Chem. News.*

[Continued from SUPPLEMENT, No. 518, page 8270.]

THE MANUFACTURE OF TOILET SOAPS.*

By C. R. ALDER WRIGHT, D.Sc., F.R.S., F.C.S.

LECTURE II.

PLANTS AND APPLIANCES USED IN SOAP MANUFACTURE.

So many variations in methods of procedure, according to circumstances, are from time to time introduced, and so many differences exist in the appliances best calculated to effect a good result under these varying conditions, that an adequate description of soap making plant in general is far beyond anything possible in the limited amount of time at our disposal; it is only practicable to attempt a hurried glance at some of the more salient features of the leading methods adopted.

As regards the methods of soap manufacture placed in the first group, according to the classification attempted in the previous lecture (*i. e.*, the methods depending on the direct neutralization of fatty or resinous acids by alkalies), it may be noticed that whereas formerly carbonated alkalies were mainly used for the purpose of acting upon oleic acid so as to form soap, their use is at present much less frequent, because the saving in cost effected by dispensing with the process of causticizing the alkali is now so small (thanks to improvements in alkali manufacture) as not to counterbalance several disadvantages attending their employment, mainly on account of the frothing brought about by the liberation of carbonic acid gas. For preparing hard oleic acid soaps by means of soda, the plant ordinarily employed consists of a steam jacketed pan, provided with an efficient agitator, such as one consisting of two sets of vertical vanes moving in opposite directions, in such wise that the vanes of the two sets interlace in passing each other. The oleic acid is run into the pan, and heated up by admitting steam into the jacket; the alkaline lye (usually also heated) is then run in gradually with continued agitation, its strength and quantity being so regulated that the mass finally resulting after the operation is completed is not too moist to set into a compact mass on cooling, and so that, while the oleic acid is completely converted into oleate of soda, there should not be any considerable excess of alkali present; a sensitive tongue being usually the means of judging adopted, and a little more oleic acid or soda lye being added, according as the mass contains too much or too little caustic alkali in excess to produce the desired "bite" or "touch" when the mass is tasted.

When carbonated alkali is used, as in what is known as "Morfit's process," the pan is usually provided with a "curb," a sort of hoop or funnel affixed temporarily to the top, to avoid overflow during the foaming up caused by the disengagement of carbonic acid, which takes place in accordance with the reaction:

$$\left.\begin{array}{r}\text{Soda conjoin-}\\ \text{ed with car-}\\ \text{bonic acid}\end{array}\right\}+\text{Oleic acid}=\left\{\begin{array}{c}\text{Soda con-}\\ \text{joined with}\\ \text{oleic acid}\end{array}\right\}+\left\{\begin{array}{c}\text{Car-}\\ \text{bonic}\\ \text{acid.}\end{array}\right.$$

Precisely similar to that ensuing when vinegar is poured upon natron, as illustrated in the preceding lecture.

Some manufacturers prefer to boil the oleic acid with weaker lyes, more or less causticized, and generally containing an admixture of salt, such as the liquid obtained by causticizing with quicklime commercial "48 per cent. soda ash," a product which contains about 10 per cent. of common salt (and other saline impurities). When the soap is partially formed, it becomes more or less insoluble in the briny aqueous liquor (especially on addition of more salt), so that this latter separates on standing; this "spent lye" being then run off, more soda lye is added and the boiling continued, and so on in much the same way as that adopted in the saponification of ordinary fats and oils by processes of the third group, which will be referred to by and by. In many cases the oleic acid is not used alone, but admixed with other various fats, etc. Sometimes an oleic resin soap is prepared by treating oleic acid and resin mixed together with caustic alkali, or by separately combining them with the alkali and mixing the products. In this case the compound of resin acids and alkali is prepared by heating together the resin and the caustic alkaline lye until complete combination has taken place, the process being effected in much the same way as in the case of oleic acid directly treated with strong lyes, and not salted out in any way. For effecting the intermixture, a peculiar kind of agitator is often used, known as "Morfit's steam twirl," consisting of a kind of rotary paddle fixed inside the pan, and made up of a long convoluted tube, with perforations at intervals along its length. This tubular stirrer is connected, by means of a hollow spindle, with the steam boiler, so that, when desired, steam can be admitted inside of it; in this way, not only is the agitator itself always kept hot by the steam, but further continuous jets of steam are made to issue through the perforations, so that rapid heating and most effective intermixture of the contents of the pan are brought about; when resin and soda lyes containing from 10 to 11 parts of anhydrous soda (Na_2O) per 100 of resin* are thus intermixed, the product is a jelly-like material consisting of the soda salts of the resinous acids, more akin in physical texture to soft potash soaps than to ordinary hard soda soaps, but capable of blending with these latter, so as to form the so-called "resin soaps" of commerce, of which the "primrose" varieties (made from the palest "window glass" resin) are the most esteemed.

Another substance analogous to oleic acid is frequently employed in the same way to form soaps by direct neutralization with alkali, viz., the "grease" recovered from the waste soapy liquors from dyeworks, calico printing, and the like; this recovered grease is usually obtained in the form of a mixture of free fatty acids with more or less coloring matter and other impurities, being produced either by addition of sulphuric acid to the soapy fluids, whereby the soap is decomposed, and the fatty acids liberated float up to the top, or by forming a lime soap by addition of calcareous compounds, which lime soap is subsequently decomposed by a mineral acid. As a rule, this kind of grease is utterly unsuited, from its color and disagreeable odor, for the manufacture of the better class of toilet soaps, even after as complete bleaching and deodorization as can be effected; but it is often worked up into inferior kinds of "brown Windsor" and similar brown soaps, to which nitro-benzene or other powerful cheap scenting materials are added, for the purpose of overpowering the unpleasant odor due to the fatty matters. Much the same remarks apply to a somewhat lesser extent to oleic acid soaps; unless the acid is purified by redistillation and other modes of treatment, the soap made from it is liable to be too much colored to be made into any other kind of toilet soap than "brown Windsor" and analogous varieties, while a peculiar faint, sickly odor is liable to be present, requiring moderately strong scents to be added for the purpose of disguising it.

It may be noticed in this connection that "brown Windsor" soap was originally a peculiar kind of soap that had been kept in stock for a long time, and remelted (often several times); so that all the free caustic alkali originally present became carbonated, and the alkaline carbonate ultimately became neutralized entirely, probably by the formation of oxidation products of a more or less marked acid character spontaneously produced (during the period of keeping or during remelting) by absorption of atmospheric oxygen, to which the deepening in tint and development of brown color was due. At the present day, however, most of the "brown Windsor" soaps are of a very different character; so far from being almost absolutely devoid of "free alkali" (to which property the reputation of the original "brown Windsor" soaps is mainly ascribable), they frequently contain very considerable amounts of that objectionable constituent; while the color is not derived from "aging" (*i. e.*, the effect of long continued keeping on certain kinds of soap), but either from the use of coarse brown fatty matters or the admixture of brown ocher or other coloring substances, or both together; in fact, all scraps that have become soiled (including the floor scrapings of the soap factory) to such an extent that they cannot be utilized in any other way are usually worked up into tablets of the "brown Windsor" class. Accordingly, this variety of soap, *as now sold*, is often found to be highly injurious to extra sensitive skins, although the article *as originally made* is perhaps one of the most innocuous soaps in the market.

PROCESSES OF THE SECOND GROUP.

As already stated, this group of processes may be conveniently subdivided into three classes, according as the operation is carried out at a comparatively low temperature (so-called "cold" processes), at a boiling temperature without extra pressure, or at a still higher temperature under increased pressure.

For the manufacture of soaps by the "cold" process only the simplest appliances are requisite, which is one of the reasons why this process is so largely employed by perfumers and others who prepare their "stock" soaps themselves on a relatively small scale. A pan provided with an agitator is, in point of fact, the only indispensable piece of apparatus; the fatty matters heated to fusion being incorporated with the alkaline lyes in the pan, and the thoroughly mixed pasty mass being then turned out into frames, where the saponification is spontaneously completed. When moderately large quantities of fatty matters (a couple of tons or so at a time) are to be treated, a "Hawes" boiler is conveniently used, consisting of an ordinary horizontal cylindrical boiler, with a shaft running through its axis, and provided with vanes, so that, by turning the shaft, the materials inside the boiler are kept well agitated and intermixed. In order to produce a finished product not containing too large a proportion of water, concentrated lyes must be used; thus, to make a soap containing not more than some 25 per cent. of water, there must be used for 200 parts of fatty matter some 100 parts of soda lye, containing about 23 per cent. of anhydrous soda (Na_2O) and about 75 per cent. of water, including that present combined with the soda as caustic soda or sodium hydroxide ($NaOH$, or otherwise Na_2O, H_2O);* such soda lye has a specific gravity of about 1·35 to 1·36 (near 37°–38° Baume). Soda lye of this strength only saponifies tallow and various other kinds of fatty matter with difficulty, weaker lyes being much more effective in such cases, although lyes of this strength (or something approaching thereto) are most suitable for rapidly acting on other classes of fatty matter, more especially castor oil and cocoanut oil. It hence often results that perfumers' toilet soaps made by the cold process are not thoroughly saponified, fatty matter not acted upon, and the corresponding quantity of uncombined caustic alkali being simultaneously present; this latter constituent, if present in any quantity, renders such soap most objectionable and deleterious to use for persons possessing tender skins, or for infants or others whose skins are apt to excoriate and chafe or chap readily. Of late years, processes for making soap at home have been advocated on the ground of economy, kitchen fat and waste grease being saved, and when a sufficient quantity has accumulated, being melted and strained clear, and then well intermixed with a soda lye prepared by dissolving powdered caustic soda in a certain quantity of warm water, the mixture being covered up to keep in the heat, and allowed to stand. The soap thus prepared almost invariably possesses the fault alluded to, *i. e.*, the saponification is incomplete, so that fat unacted upon and uncombined caustic soda are simultaneously present; in consequence, such soap, although possibly very suitable for scrubbing floors, or even for laundry operations, can by no means be recommended for toilet purposes. Somewhat the same remarks apply to a class of products also prepared by cold processes, and designated as toilet soaps (but often by no means deserving the name, that have come largely into the market of late years, owing to their attractive appearance rather than to their intrinsic good qualities, viz., *transparent soaps made without spirit.* Although a few makes of this class of article are to be found to which these objections do not so largely attach, yet it is, unfortunately, the fact that the majority of the products of this type are prepared by a modification of the cold process, employing strong caustic lyes in considerable excess (without which transparency does not seem to be so readily attainable); the objectionable action of this constituent being yet further intensified by the incorporation into the soap mass of a large proportion of *sugar*, which causes the whole to dissolve rapidly, especially in warm water, thus increasing the amount of alkali brought into contact with the skin during use. This class of products will be further discussed hereafter; but it may be noted that, in addition to their other demerits, these articles rarely contain as much as one-half their weight of actual soap, the major half being water, sugar, and saline matters, added to give a fictitious appearance of solidity.

In the manufacture of soft soaps and marine soaps (soaps chiefly made from cocoanut oil, and possessing the property of lathering with sea water), the appliances used essentially consist of a pan or copper, provided with a steam worm or coil of pipe connected with the boiler in such fashion that steam passed through the worm will heat up the contents of the copper. Frequently two worms are provided, one with perforations, so that jets of steam continually pass up through the mass of soap when the connection with the boiler is open, so as to boil up the contents of the copper with "wet" steam; the other without perforations, but connected with a superheater, or high pressure boiler, so as to give the means of attaining a higher temperature than 100° C., without blowing steam directly into or through the mass, and thus evaporating water by means of "dry" steam. A curb to prevent frothing over, and a "fan" to break bubbles and froth, are also useful adjuncts. The latter consists of a vane revolving on a vertical axis, and adjustable at different elevations as required on that axis, so that it can be made to revolve at any desired horizontal level inside the copper, or altogether removed therefrom. The method of working varies somewhat in different factories—in some cases the whole of the oil or fatty matter to be saponified being introduced into the copper, and the alkaline lye then run in in portions at a time, and boiled up with wet steam after each addition; in others, the oil and alkali being both introduced in portions at a time. When saponification is complete, the mass is boiled down, so as to evaporate water, by means of the dry steam coils. In the case of "marine" soaps, an addition of salt or brine, to give increased hardness, or of silicate of soda to increase the detergent action, or of both together, is usually made by crutching in the materials to be incorporated before framing or while in the frame; soaps thus treated, however, are by no means desirable materials for toilet use, either as one or as constituents in a blended mass, on account of their alkalinity; they are, however, occasionally used. Some Continental makes are improved (?) by the addition of sugar as sirup to the product, giving as result a material which is sufficiently white to permit of tinting all sorts of pretty colors, and consequently of being rendered very attractive in appearance; but the quality of these substances (from the point of view of applicability to the human skin) is usually of the worst possible.

Soft soaps are but rarely used as ingredients in toilet soaps when manufactured into tablets, the presence of potash compounds being usually insured (when required) in other ways, notably by using a mixture of potash and soda to saponify fatty matters instead of the latter alkali alone, or by pearlashing, *i. e.*, adding pearlash to the remelted mass. Certain "toilet creams" and analogous cosmetics more or less of the nature of soap are, however, essentially soft potash soaps. Usually,

* Lectures delivered May, 1885, before the Society of Arts, London. From the *Journal S. A.*

* Resin, or colophony, mainly consists of two isomeric acids of formula $C_{20}H_{30}O_2$ (sylvic and pinic acids), so that 100 parts of either acid would correspond with 10·26 parts of Na_2O. Other analogous organic acids, or their anhydrides, have also been described (pimaric acid, abietic anhydride, etc.) as present therein. On the whole, the average combining value of the resin acids present is usually near to 295–310, corresponding with from 10 to 10·5 parts of anhydrous soda, Na_2O, per 100 of resin.

* The remaining two per cent. being saline impurities, such as chloride and sulphate of sodium. This represents a fairly pure commercial caustic soda; but articles of still greater purity are in the market.

these substances are prepared by the cold process, using potash only as a saponifying agent, rather than by the boiling process employed in the manufacture of ordinary household soft soap.

Soaps made under pressure, when of good quality, are to some extent used as "stock" soaps, *i. e.*, as the basis of toilet soaps prepared therefrom by refining or blending together, or otherwise treating to improve the quality. The plant used in their manufacture essentially consists of a pressure boiler into which the lyes and fatty matter are introduced, the temperature being then raised until the requisite pressure is attained (which varies with the fatty matters, being the greater the less easily saponified). In Dunn's method of working, comparatively low pressures are employed (20 lb. to 65 lb.), the soda lyes being causticized before use; in Bennet and Gibbs' method, carbonated alkali is used in conjunction with much higher pressures (15 to 20 atmospheres), the materials being continuously pumped in at one end of the boiler and emerging as finished soap, ready to put in the frames, at the other end, and being continuously agitated while passing through.

PROCESSES OF THE THIRD GROUP.

In order to prepare soap on the large scale adopted by "soap boilers" employing the third class of process in which glycerin is separated from the soap during manufacture, much the same kinds of pans and steam pipes are employed as those above described, saving that their dimensions are usually materially greater;* thus coppers capable of holding 30 to 40 tons, and even more, of soap at one operation are not infrequently used. The products thus formed may be classified into three groups, respectively *curd*, *fitted*, and *mottled* soaps; up to a certain extent the process of preparing all three kinds is the same, the main differences being in the latter stages.

The fatty matter to be saponified is heated together with caustic lye of sp. gr. 1·05 to 1·09, in quantity not quite sufficient to produce complete saponification, weaker lye being used at first, and stronger being gradually added as the operation progresses; the effect of this is to "kill" the fatty matters or "goods," *i. e.*, to convert them into a kind of emulsion not containing any visible grease. After this operation has proceeded to the requisite extent, a certain proportion of salt (or brine) is added, which causes a separation to take place between the imperfect soap formed and the brine produced by the solution of the salt, the latter sinking to the bottom and retaining in solution the glycerin formed during the saponification; this brine is then pumped away by means of a pump connected with the base of the pan, and the partially finished soap boiled up again with stronger lye so as to complete the saponification. For curd soaps this operation is continued, using the closed steam coils, until by evaporation the soap acquires a peculiar consistency, the lyes running away from the curd on standing, owing to the insolubility of soap in moderately strong alkaline lyes, just as it is insoluble in brine; the curd is then allowed to stand a while, and finally ladled or pumped out into the cooling frames (boxes of wood or iron capable of being taken to pieces, and held together with nuts and screws), in which it concretes on cooling and standing, forming solid blocks which are subsequently cut up into slabs some 2½ to 3 inches in thickness, these being again cut into bars weighing some 3 lb. each. According to the length of time during which the boiling has been continued, *i. e.*, according to the amount of evaporation that has taken place, so is the quantity of water associated with the resulting curd soap variable; when comparatively weaker lyes run away from the curd at the close, the soap is more moist than when the final lyes are stronger; in any case a certain amount of alkaline lye is apt to remain disseminated through the mass, although the majority of such entangled fluid separates to the bottom of the cooling frames, and runs away through perforations for the purpose; the presence of this lye generally renders curd soaps somewhat alkaline, and hence less fitted for toilet use than for laundry operations. In order to avoid this, when requisite, the curd is boiled up more than once with weaker lyes, or with weak brine alone, so as to wash out the entangled caustic solution, the lye that separates after each boil up being run off; notwithstanding, notable amounts of caustic alkali and chloride of sodium are usually present in curd soaps, due to the incomplete separation of lye. Recently, a patent has been taken out for the more complete removal of lye, by means of a centrifugal machine, in which the pasty curd is placed, and it is claimed that almost entire removal of lyes can thus be effected with proper care; the same result, however, is more frequently obtained by "liquefying" the soap, or "fitting" it, which operation essentially consists in thinning the soap to a great extent with weak lyes or water (partly derived from the steam condensed in heating up with wet steam after partial cooling down), boiling up, and then allowing to stand for a long time, when the mass separates into three layers, viz., a frothy scum, or "fob," on the top, and at the bottom an aqueous mass containing iron (from the pans) and other impurities, which, being heavier, separate on standing, and being usually very dark colored (especially when soda lyes are used containing small quantities of sulphide), are known as "negur," or "nigre;" the central portion, or "neat soap," is almost devoid of free alkali from admixed lyes, and is usually colorless, or nearly so;† after removing the fob, the neat soap is carefully ladled or pumped off into the cooling frames without disturbing the nigre, which is utilized in the production of mottled soap or other more colored varieties. The fitted soap thus obtained always contains a considerable amount of water (some 35 to 40 per cent., and sometimes more); while curd soap that has been boiled on comparatively strong lye contains considerably less (some 20 per cent., or thereabouts); the precise amount of associated water depending on the way in which the final boil is effected and the amount of evaporation taking place therein when dry steam is used. The term "fitting," strictly speaking, relates rather to the production of a mass of a certain appearance or consistency than to the actual degree of purification effected, although the two are intimately associated; thus the soap is said to be of a "fine" or "coarse" fit, according to the amount of dilution, and consequent separation of impurities, which accompanies the development of peculiar degrees of consistency, judged of in practice by taking up a portion of the mass on a trowel and noticing how it slides off therefrom, its appearance as it cools, and so on.

* Formerly pans heated by fires underneath instead of steam ("wet" or superheated) were largely employed; but of late years their use has considerably diminished in favor of steam pans, on account of the much greater ease with which the operations can be controlled, besides various other advantages.

† A soap-boiler would compare society at large to a fitted pan of soap rather than to a flagon of ale, "Fob at top, nigre at bottom, and neat soap in the midst," instead of "Froth at top, dregs at bottom, and good liquor in the middle."

When a curd soap is made from materials that yield, besides soda soap, an admixture of colored matters derived from impurities (iron soap, alumina soap, ferruginous matters from the pan, sulphide of iron, etc.), the character of the cooled mass varies notably with the amount of water present; if much water be present, an action goes on in the cooling frame analogous to that taking place in the fitting operation during the subsequent standing, *i. e.*, the colored heavier impurities more or less completely sink to the bottom as a dark-colored layer; but if the quantity of water be not in excess of a certain amount, and the rate of cooling be properly adjusted, the matters do not subside, but simply segregate themselves into veins irregularly distributed throughout the mass, leaving comparatively uncolored soap as the matrix in which the veins run. When cut across, such a soap accordingly shows a marbled, or *mottled* appearance. Formerly this appearance was considered a guarantee of quality, *i. e.*, it intimated that the amount of water present did not exceed a certain amount (some 20–25 per cent.); and inasmuch as "mottled soaps" for this reason acquired a reputation, it became customary to enhance the mottle by purposely adding coloring matter, and more especially either iron oxide as such or solution of sulphate of iron, which, becoming decomposed by the soap, ultimately formed ferruginous insoluble matters in the mass. "Castile" soap thus prepared from olive oil accordingly long enjoyed a high reputation, partly on account of the nature of the oil used in its production, partly from the existence of the mottle in it. Nowadays, however, such "appearances are deceptive" to a high degree; a large amount of misdirected ingenuity has been brought to bear, not only on the substitution of cheaper oils for olive oil (a substitution not necessarily involving a depreciation in the useful qualities of the soap), but also in inventing methods of manipulation, by means of which a mottled appearance can be communicated, notwithstanding that the amount of water present very largely exceeds that compatible with the old-fashioned natural mottle. These methods essentially consist in partially cooling down the watered soap, and, when it has gained a particular consistency, owing to thickening while cooling, stirring in the pigment intended to produce the mottle, the segregation into veins then going on during the further cooling and solidifying, just as in the true mottled soaps, which were equally thickened at much higher temperatures, owing to the smaller amount of water present.

Excepting in so far as genuine Castile soap is employed as an ingredient in blended masses, mottled soaps are not used for the preparation of the better kinds of toilet soaps. Some of the cheaper varieties, however, are nothing but ordinary mottled soaps cut and stamped into tablets, in some cases the marbling being effected by means of a comb or blade passed through the mass before complete solidification, and previously dipped in a tinting composition, so as to develop colored streaks in the mass. Some Continental cocoanut oil soaps of this description, of the vilest character in all respects, are occasionally to be met with. On the other hand, curd soaps and fitted soaps are very largely used as the basis of the better classes of toilet soaps; in fact, a well fitted soap made from selected sound materials is probably the very best basis of the kind that can be obtained; in this country, however, soaps made by cold processes, and curd soaps, are employed to an extent probably greatly surpassing that of any other kinds.

PROCESSES OF THE FOURTH GROUP.

The principal class of manufacturers' soaps coming under this head consists of resin soaps, prepared by intermixing with a boiled tallow or other soap of the curd variety the resin soap obtained by boiling together soda lyes and resin; the crude product thus obtained is almost invariably "fitted" as above described before framing. Many of the resin soaps in use, however, are prepared by acting with alkaline lyes *simultaneously* on fatty matters and resin, so that the saponification of the glycerides and the direct saturation of the resin acids go on side by side.

Resin soaps prepared in one or other of these ways are largely used as ingredients in blended toilet soaps, a more ready degree of lathering, greater toughness, and less liability to crack in stamping being thus gained. Some of the best of the cheaper class of so-called toilet soaps are simply fitted resin soaps of a good grade (preferably "primrose" made with the lightest colored resin) cut to shape, partially dried, and stamped, either with or without the previous addition of essential oils, etc., to scent the mass.* The coarser and darker resin soaps, however, being usually made from much lower qualities of fatty materials (horse grease, kitchen fat, and similar low class greases), are not to be recommended for application to the skin, although they are actually used to a large extent in the production of soaps which, being tinted brown, do not require the finer kinds of fats and oils in their preparation, so far as color is concerned; while being strongly scented (usually with cheap essential oils or "mirbane") the more or less pronounced disagreeable odor due to the coarse fats is practically disguised, at any rate for a time.

MANUFACTURE OF TOILET SOAPS.

The preceding remarks and descriptions of the leading processes employed in the manufacture of soaps, generally on the large scale, require to be supplemented by a brief account of certain other processes through which the crude products of the large soap factory are put in order to "refine" them, and otherwise to render them more attractive in appearance and more convenient in use for purposes of personal ablution. As already stated, in the case of many of the cheaper classes of so-called "toilet" soaps, these further processes are wholly omitted, excepting in so far as they relate to the mechanical processes of subdividing the comparatively large blocks obtained in the factory, and stamping into tablet form; but with the better classes of fancy soaps these further processes are frequently of the highest importance.

* Resin, either alone, or previously dissolved in glycerin, is sometimes added to soap masses for the preparation of particular varieties of toilet soaps.

As regards the manufacture of toilet soaps in general, the subject may be conveniently treated under the following heads:

I. *Preparation of Soaps by Cold Processes.*—(*a*) Opaque soaps; (*b*) transparent soaps not prepared by dissolving stock soaps in spirit.

II. *Manufacture of Transparent Soaps from Stock Soaps by Treatment with Spirit.*

III. *Preparation of Soaps by Remelting.*—(*a*) Processes of remelting single kinds or blends; (*b*) incorporation of ingredients for improving quality or giving special properties.

IV. *Machinery and Appliances employed in the Preparation of Bars and Tablets.*—(*a*) Manufacture of "milled" soap; (*b*) appliances used in the formation of tablets from blocks of molten soap.

I. PREPARATION OF TOILET SOAPS BY COLD PROCESSES.

(*a*) *Opaque Soaps.*—On account of the simplicity of the plant required for the manufacture of toilet soaps by processes of this class, these methods have long been employed by perfumers and others making comparatively high priced soaps on a scale small as compared with that adopted in large soap-boiling establishments.

In the preparation of perfumes by the process known as *enfleurage*, cakes of prepared fatty matters, and in some cases oils, are made to absorb the volatile odorous matters given off from delicately scented flowers, by exposing the cakes or oils to a gentle current of air passing through or over a mass of the flowers to be treated; or, in the older way of working, by making a pile of alternate layers of flower petals and cakes, and allowing them to stand for a day or two, during which time the volatile essential oils of the flowers are to a large extent absorbed by the cakes, when the pile is taken asunder, and the exhausted flowers replaced by a fresh batch, and so on until the cakes are impregnated with flower scents to the required extent. By macerating in alcohol the cakes thus scented, or by agitating therewith, the essential oils are again largely dissolved out from the cakes of fatty matter or the liquid oils thus treated, producing flower essences used by the perfumer in compounding his various scents and perfumes, and leaving behind the fatty or oily matter insoluble in spirit. This undissolved substance being necessarily composed of fats and oils exhibiting the least possible tendency to become rancid (which, should it occur, would more or less deteriorate the essence ultimately prepared) is a most eligible material for the preparation of a high class soap, the more so as a certain amount of delicate perfume is always retained; and accordingly the manufacture of soap therefrom by a cold process (so as to avoid dissipating and deteriorating perfume as far as possible) is a branch of business often cultivated by the perfumer. Unfortunately, the necessity of the case prohibiting the application of a high temperature, and perfumers not being necessarily men of profound chemical attainments, the manufacture of perfumed soaps in this way often leads to the preparation of products containing far greater amounts of free alkali than are at all compatible with excellence, when the products are viewed as soaps only; incomplete saponification (causing simultaneous presence of free alkali and fatty matters not acted upon) is often exhibited by such soaps; and when the greasiness thus produced is avoided, it is usually only effected by the employment of a considerably larger proportion of alkali than that chemically equivalent to the fatty glycerides used, so that, in any case, a notable amount of free alkali is more often present than not.

The amount of high class fatty and oily matter obtained as residues from flower essence preparations being absolutely only small in amount, these materials are usually supplemented with analogous substances of the ordinary type, such as sweet almond oil, clarified beef marrow, refined lard, and the like; often these materials alone are employed. Owing to the comparatively small scale on which the operation is usually conducted by the perfumer, products of this class are sometimes designated "little pan soaps." The fatty matters of selected qualities are first melted together, and strained clear if necessary; then about half the alkaline lye (sometimes caustic soda only, but often a mixture of caustic soda with a smaller quantity of caustic potash) is gradually added with continual stirring, and the whole thoroughly well intermixed; the remainder of the lye is then gradually added with continual agitation, the temperature not being allowed to rise too high (usually not beyond about 65° C.); after which the soap is run into cooling frames, much smaller in dimensions than those ordinarily employed by the boiler of household soaps, covered up, and allowed to stand; usually, the temperature rises somewhat spontaneously, owing to the development of heat as the saponification progresses. Various tinting materials and perfumes are usually added, preferably at as late a period as possible consistent with the possibility of complete intermixture with the mass. Some makers reverse this mode of procedure, the whole of the lye being placed in a suitable vessel provided with an agitator, and warmed, after which the melted fatty matters are gradually added and thoroughly incorporated. In order to obtain a resulting product of proper consistency, lyes must be used of such strength that the total mass does not contain more than about 25 per cent. of water; this is effected by using for one hundred parts of fatty matter about 50 parts of lyes sp. gr. 1·35 (near to 37° Baume); such lye, if tolerably pure caustic soda, free from any considerable amount of sodium chloride and sulphate, contains about 23 to 24 per cent. of actual anhydrous soda (Na_2O) and about 75 per cent. of water (including that combined with the soda as hydroxide of sodium); so that about 11·5 parts of anhydrous soda are employed per 100 of original fatty matters. If cocoanut oil (finest quality) be used as a portion of the fatty acid mixture, as is often the case with French toilet soaps, a larger proportion of soda is requisite to bring about complete saponification without introducing too large an excess of alkali than is permissible with fatty matters mainly consisting of stearine and oleine, on account of the much lower mean equivalent of the fatty acids contained therein; pure stearine theoretically requires 10·45 parts of anhy-

drous soda for perfect saponification, and pure oleine 10·54, and cocoanut oil about 14·6 parts.

The great fault of all processes of this class is that on account of the varying amounts of impurity apt to be present in the alkali used, and of the different equivalents of the various fatty acids contained in the material, *it is almost impossible to rely upon obtaining products of exactly the same character by adhering to any routine method of procedure;* if certain proportions are fixed upon as giving a good yield on the average, some batches are liable to contain an excess of alkali to an objectionable extent, and others to contain unsaponified fat, on account of the presence of too little actual caustic soda in the lyes used to effect complete saponification; these defects being quite apart from the circumstance that it is by no means uncommon to find that unsaponified fat and free alkali are simultaneously present, owing to incomplete reaction between the materials employed; for which reasons soaps prepared by boiling and subsequent purification by fitting, or other equivalent processes, are greatly to be preferred to soaps made by the cold process, more especially as the perfection to which the "milling" process (described below) has now been brought permits of the introduction into the soap mass thus obtained of the most delicate perfumes, with even less liability to deterioration by the action of heat than in the cold process. One advantage, however, cold process soaps necessarily possess over boiled soaps, viz., that the glycerin set free during the saponification is retained as a constituent; but at the present day processes for recovering glycerin from spent soap lyes are worked to such an extent as to make refined glycerin but little more costly than fatty matters of good quality; accordingly, it is easy to add glycerin to a boiled soap mass either while molten before framing, or during milling, without materially increasing the cost of the resulting product.

(*b*) *Transparent Soaps made by Cold Processes.*—It has long been known that when tallow or other analogous soaps are dried and dissolved in alcohol, the solution obtained when evaporated leaves the soap behind as a translucent mass; the peculiar molecular constitution of soap, as thus obtained, is spontaneously assumed to a greater or lesser extent by certain kinds of soap when prepared by the cold process, notably in the case of castor oil soda soap. Addition of a little spirit of wine, or of more glycerin than is formed during the saponification, greatly facilitates the production of this "colloid" form of soap, while the same result is also brought about by the incorporation with the mass of sugar, and to some extent of other substances, notably petroleum. To so great an extent is thus result effected, when a considerable amount of sugar is added (15 to 30 per cent.), that, under suitable conditions, tallow may be largely incorporated with the mass of fatty matter used, without interfering with the transparency, provided that the saponification is carried out in such a fashion as to be complete, *i. e.*, that no unsaponified stearic glyceride remains in the product, otherwise muddiness or spottiness is apt to result. In order to make sure that all the fatty matters employed are actually saponified, it is usual in this country to add a quantity of caustic soda solution notably in excess of that chemically equivalent to the fatty acids (the excess as found by analysis of many kinds of commercial products of British origin usually varying from about ⅙ to ¼—15 to 25 per cent.) of the soda actually present in the form of soap. Some few makers, however (mostly Continental ones), prepare products containing much less free alkali than the smaller of these amounts. As a general rule, cocoanut oil largely enters into the composition of this class of transparent soaps, often with the result of communicating to the hands or objects washed with the soap a very disagreeable odor.

As an illustration of the nature of the materials used in making this class of soap, the following formula and general directions may be quoted (*Journal Society Chemical Industry*, April, 1883):

"Melt the following with agitation: 10 kilos. cocoanut oil, 10 kilos. castor oil, 8 kilos. neutral tallow, and saponify them at 50° C. with 14 kilos. of caustic soda at 38° B., and continue stirring until pastiness sets in. Add 8 kilos. loaf sugar in 8⅓ liters of water at 85° C., taking care to bring it in gradually. As soon as the soap begins to solidify at the sides, the boiler is jacketed with a water-bath, kept at 80° C. until it has attained the proper consistency, and the scum has separated. Add 20 to 30 per cent. of loading, agitate well, and then stir in a boiling solution of 1 kilo. crystallized soda in 1 liter of water; dye, perfume, and finish off the batch as usual."

The "loading" here mentioned is made from mineral oil and soap shavings, the petroleum being previously deodorized by means of bleaching powder solution and hydrochloric acid, and subsequently treated with chalk to remove adherent acid. "Thirty kilos. of purified oil are heated to 50° C., mixed with 2 kilos. of well dried soap shavings, and heated until a sample on being taken out solidifies on cooling."

It is evident from the formula that even without the "loading," the resulting mass would not contain as much as half its weight of actual soap, for the ingredients consist of 28 kilos. fatty glycerides (representing a little more than the same weight of anhydrous soda soap, about 29 kilos.) and 32⅓ kilos. of water, soda, and sugar; so that when 30 per cent. of loading is added, the resulting mass would not contain much more than one-third its weight of actual soap. On the other hand, the total alkali used (partly as caustic soda solution, partly as crystals) represents about 113 per cent. of the amount chemically equivalent to the fatty matters, furnishing consequently a soap with an excess of "free alkali," equal to about one-eighth of that present combined as soap; a quantity, as will hereafter be seen, very far in excess of that compatible with good quality as regards injurious action on tender skins. The quantity of sugar prescribed, it may be noticed, represents some 13 per cent. reckoned on the mass without "loading," and about 27 per cent. of the actual soap formed.

This formula, apart from the loading, results in the production of an article of distinctly better quality than most of the transparent soaps of this kind now sold in Great Britain; for these soaps usually contain a still larger excess of alkali (ranging from 15 to 25 per cent. of that present combined as actual soap) and a still higher percentage of sugar (20 to 25 per cent., and even more, being often found); while the amount of actual soap in tablets fresh from the factory (and not dried by exposure in shop windows) rarely exceeds 45 per cent., so that these articles are about as much a compound of sugar candy and soda crystals as they are soaps, if not more so.

It should, however, be remarked that a few makes of the better class of this variety of transparent soap are to be met with, not containing so large an excess of alkali, and not so large a sophistication with sugar; the transparency being, in some cases, largely brought about by the admixture of a certain amount of spirit, or glycerin, or both, with the mass in the final stage (the spirit, however, not being applied in the way employed in the manufacture of the "spirit-made transparent soaps" hereafter described). Such a product (excepting as regards free alkali, which is still in marked excess) is obtainable by adopting the following formula: Heat to 65° C. a mixture of tallow, 20 parts; palm oil, 12 parts; castor oil, 8 parts; and then gradually run in 20 parts of caustic soda lye, at 38° B.; when intermixed, crutch in 20 parts strong alcohol, and subsequently 20 parts of glycerin and 10 of syrup, containing half its weight of loaf sugar. Color and perfume *ad libitum*.

Did time and space permit, numerous other formulæ in actual use for the preparation of cold process transparent soaps might be quoted, all more or less of the same general character, viz., that they result in the production of a compound of a variety of soap (not by any means always intrinsically of the choicest kind) with more or less toffee and washing soda, and a liberal proportion of water; so that, even when the finished tablets are sold at a price materially lower than that at which a really good genuine toilet soap can be produced with a reasonable margin for honest profit, the value received by the purchaser (reckoned on the *quantity* of actual soap present, and irrespective of its *quality*) is usually less than he would obtain by buying a much more highly priced opaque genuine toilet soap. The "Philosopher of Chelsea" is credited with an unkind remark to the effect that the population of the United Kingdom is "some thirty millions, mostly fools;" but in truth, the magnitude of the trade now done in this class of transparent soaps (often of a character only to be described as simply abominable for the purpose of application to sensitive skins), just because they are pleasing to look at, would go far to vindicate his memory from the charge of sarcastic exaggeration which at first might appear to attach thereto.

II. TRANSPARENT SOAPS MADE FROM STOCK SOAPS BY SOLUTION IN BOILING SPIRIT.

This variety of soap, when properly made, has the merit of containing much larger proportions of actual soap than the transparent soaps made by the cold process just discussed, while it ought to be almost devoid of free alkali, since solution of dry soap in strong spirit leaves alkaline salts other than soap undissolved; unfortunately, a good deal of the transparent soap made (nominally at least) by this process is found on analysis to be open to other serious objections, which, however, are in no way applicable to all the different makes sold in this country.

It has long been known that ordinary household soaps, when more or less deprived of water and dissolved in strong spirit of wine, are thus separated to a great extent from saline matters, such as sulphate and carbonate of soda; so that the solution thus obtained usually contains a less amount of free alkali relatively to the actual soap present than was originally present; and further, that the alcoholic solution thus obtained furnishes, by distilling off the spirit, a mass of purified soap which is more or less clear and translucent after standing until the last traces of spirit have almost completely evaporated. Accordingly, such purified soaps, made from first-class fatty matters in the first instance, have long enjoyed a deservedly high reputation as toilet soaps, not only on account of their pleasing appearance (especially when judiciously tinted), but also on account of their freedom from irritating action on sensitive skins through the absence of free alkali in any notable quantity. Further, an admixture of purified glycerin with the mass has long been known as improving the soap, not only by aiding the transparency, but also by rendering the mass more bland and emollient in use; while certain kinds of resin, or of resin and glycerin jointly, also produce much the same effect. Unfortunately, but little of the transparent soap in the market nowadays is of this old-fashioned, admirable type; the cost of alcohol in Great Britain, on account of duties, has induced manufacturers to substitute methylated spirit for pure alcohol, with the result not only of communicating to the product a coarse, rank odor (more especially noticeable after keeping till the perfume added to disguise the smell has evaporated), but also of impregnating the mass with substances which, in some cases at any rate, are liable to act injuriously on the skin. When this evil is aggravated through the desire of further cheapening the product, first, by the use of coarse fatty matters for the preparation of the original stock soap, and secondly by the substitution of sugar for glycerin, the result is the production of an article which is often very far inferior to the older excellent makes of this class of soaps; for although irritation to sensitive skins, caused by the presence of free alkali, is avoided (carbonate of soda being left undissolved by the alcohol employed), yet at least equally unpleasant effects are liable to be produced (in certain individuals, at any rate), either from rancidity of fatty matters originally employed or empyreumatic matters from the methylated spirit, or both conjointly. Several members of my own family, as well as various friends, are unable to use this sort of soap without the almost invariable production of blotching or cracking of the face skin, or other similar inconveniences.

From the point of view of the method of manufacture, the class of soaps now under consideration is quite distinct from those varieties of "cold process" soaps which are rendered transparent by the intermixture of alcohol with the mass at a certain stage of the operation, although the physical effect upon the resulting soap is much the same in each case, a colloid modification being thereby generated. In particular, the cold process transparent soaps are practically (though not necessarily and unavoidably) always intensely alkaline; while the true spirit-made transparent soaps now under discussion are (when properly prepared) practically neutral, partly because they are usually made from fitted soaps containing little or no free alkali, and partly because the solution in alcohol eliminates alkaline salts to a very large extent, if not entirely, should they have been present in the original stock.

During the process of solution, which is effected in a covered vessel forming a kind of still, the alcohol vapor given off is condensed by a worm, either running back to the dissolving vessel or being kept apart. It is stated that crude methylated spirit, when first used for thus dissolving soap, furnishes a much less unpleasantly smelling distillate, and a similar improvement takes place at each subsequent time of using, so that ultimately a spirit is obtained nearly free from the rankness of the original substance, and consequently capable of giving a much better product, especially if employed to dissolve a better class of stock soap. If a transparent soap containing a high percentage of soap is required, it is indispensable that the residue left in the still, after distilling off as much spirit as possible, should be exposed to slightly warm air for a lengthened period, in order to allow of the removal by evaporation of the last portions of alcohol and water (the latter mainly being that originally contained in the stock soap, which, though usually shaved and dried, as subsequently described in the case of milled soaps, is rarely rendered actually anhydrous before treatment). Complete transparency, in fact, is not shown by the raw product, which is usually very muddy until clarified by long standing and evaporation of alcohol, etc. The development of perfect clearness is considerably facilitated by the presence of glycerin or cane sugar to the extent of some 10 to 15 per cent.; resin soaps, other things being equal, usually yield clearer products than soaps not containing resin. A good "primrose" soap thus clarified, and rendered transparent by solution in alcohol, furnishes a product very little colored, about the tint of very light golden sherry; most of the transparent soap of this class as sold, however, is much darker, probably from the use of cheaper and darker stock soaps, or from the development of color either by alteration of certain constituents in impure alcohol, or by the action of air upon the original stock soap, causing browning. In order to obtain a product of uniform appearance, the lighter colored batches can be deepened in tone by addition of caramel or other convenient soluble coloring matter.

III. REMELTED SOAPS.

(*a*) *Process of Remelting.*—A considerable fraction of the various toilet soaps of British make are prepared by blending together different varieties, by the simple process of remelting them together in a pan provided with a steam jacket. Sometimes the bars to be melted are arranged vertically or horizontally around the sides of the pan, in which a little water is first placed to avoid drying, and are left to themselves to soften and run down gradually, more being similarly added from time to time, and the whole mass being finally well intermixed by stirring or "crutching" by hand, and then cast in frames of smaller dimensions than those usually employed by the soap boiler; in other cases, the pans are provided with mechanical stirring or crutching arrangements, worked either continuously or intermittently; sometimes, to facilitate the fusion, the bars of soap employed are reduced to chips or shavings by means of a kind of plane worked by hand, or by a rotating blade affixed to a disk, and acting on the same principle. Certain practical minutiæ require to be carefully attended to, in order to obtain a good result with certain kinds of soaps, more especially when several varieties are to be blended together, thus, if the heating be carried on too long in certain cases, the mass thickens in consistency, not merely from drying by evaporation, but also in consequence of a physical alteration in texture; if too much agitated, especially with a rotary stirrer, there is a liability to incorporate air bubbles with the mass, rendering it vesicular and spongy, which is apt to deteriorate the finish of the tablets ultimately formed, although it communicates to them the convenient property of not sinking in water, so that, when in use, the tablet does not subside to the bottom of the bath or basin, but floats. If incompletely heated or stirred, small masses of unfused soap are disseminated throughout the whole like plums in a pudding, giving a spotted and speckled appearance, especially when coloring matters are added so as to tint the soap. Such coloring matters, when added in the form of pigments, require to be thoroughly ground and levigated, so as to reduce them to impalpable powder, otherwise they are apt to render the soap gritty; when soluble colors are used, they may conveniently be previously dissolved in some appropriate menstruum, such as alcohol or a boiling aqueous solution of soap. Pigments containing poisonous metals, especially mercury, lead, arsenic, and copper, should be carefully avoided; for although the presence of small quantities of insoluble compounds of these metals in the lather produced during use is not likely to affect persons with healthy skins, there is a possibility, in certain cases, of injurious action; and all such contingencies, even though very remote, should be avoided in a high-class article. At the present day, however, vermilion, red lead, and analogous poisonous metallic pigments of this class, are frequently used, principally because soaps thus tinted will bear exposure to light without fading, while if organic (natural or artificial) non-poisonous colors be employed, there is frequently a great liability to bleaching of the color by exposure to light, for example in a shop window.

(*b*) *Intermixture of Ingredients for the Purpose of Improving Quality.*—It is obvious that the process of remelting and blending together various kinds of stock soaps is not capable *per se* of diminishing the average amount of free alkali present in the materials; but by the addition of sutable ingredients to the mass, more or less complete removal of free alkali may be brought about. In certain cases this result is to some extent effected by incorporating with the mass a small percentage either of resin (alone or dissolved in glycerin), or oleic acid, or even palm oil or other easily saponifiable glyceride, a partial saponification then taking place, so that the excess of alkali becomes more or less neutralized by combination with fatty or resinous acids; but these methods are by no means universally applicable with advantage, although in certain cases they are highly convenient, more especially for scouring soaps, used in certain industrial processes in connection with textile fabrics. Boric acid has also been employed for the purpose, the product of its combina-

tion with the excess of soda (borax) being well known as a useful variety of detergent analogous to silicate and aluminate of soda, more especially in soaps intended for the laundry, borax being reputed to have a whitening action on linen, etc., cleansed therewith; whether it is of equal advantage when applied to the human skin, however, may well be doubted.

Certain metallic salts, notably sulphate of iron, have for many years been used as an admixture in various highly esteemed soaps, their action partly consisting in neutralization of free alkali by combination therewith of the acid of the metallic salt, while the metallic oxide is set free and serves as a coloring matter; thus "Castile soap" of the old fashioned kind (a far superior article to much now sold under that name) is produced by adding sulphate of iron to the curd, so that some of the free alkali becomes converted into sulphate of soda, while the oxide of iron formed as complementary product ultimately gives rise to the peculiar mottle characteristic of that kind of soap. Of course the modern mottles formed by incorporating oxide of iron as such, or analogous pigments, are incapable of producing any action of the nature of diminishing the free alkali by neutralization, there being no constituent capable of so acting in the coloring matters used.

Metallic salts, other than those of iron, have usually the disadvantage, not only of introducing into the composition metallic substances often of an objectionable character, but also (like iron) of developing more or less marked color in the mass, so as to interfere with the production either of untinted products or of tablets tinted to fancy; it is evident that if, instead of a metallic oxide remaining permanently in the mass, there could be developed a volatile substance removable by evaporation, these objections would be obviated, while the advantage of neutralization of excess of alkali would be retained. Such a result I have recently found to be brought about by the employment of a salt of ammonia (such as the chloride or sulphate), which, when incorporated with the soap in quantity chemically equivalent to the amount of free alkali to be eliminated (a proportion readily ascertainable by analysis of the materials), gives rise to the production of a neutral alkaline salt by the reaction of the ammoniacal salt on the free alkali, and of free ammonia mixed with more or less carbonate of ammonia (according as the free alkali was caustic or carbonated), which latter compounds evaporate and are removed, partly at the moment of intermixture, but more especially during the subsequent mechanical processes through which the soap has to be put in order to prepare finished tablets, the slabs, bars, and partly formed tablets, etc., being necessarily exposed to the air for drying and hardening before the finished tablets are fit for boxing and sending into the market, during which period practically all the ammonia and carbonate of ammonia evaporate. Even should traces of ammonia be retained, they are of no practical consequence, inasmuch as this form of alkali, as is well known, is comparatively destitute of the corrosive action on animal tissues exerted by the fixed alkalies—potash, and especially soda; whence the use of ammoniacal fluids in certain stages of the woolen industries, where fixed alkalies would seriously injure the fabrics. Accordingly, the patented processes founded on these observations afford a simple and convenient method of getting rid of that *bete noire* of the toilet soap refiner, the uncombined alkali naturally present in the stock soaps employed by him as received from the soap boiler and wholesale manufacturer. Obviously the de-alkalization by this process can also be carried out in the preparation of the stock soaps themselves.

It is of interest to notice that a want of chemical knowledge sometimes leads inventors to take out patents for processes which in practice lead to results quite the opposite of those intended. Thus, a recent patent recommends the incorporation of bicarbonate of soda with soap as an ameliorating agent; it is true that if the excess of alkali were present in the *caustic* state, it would become carbonated by the action of this ingredient, just as it would by simple exposure to air so as to absorb carbonic acid; but this effect would be obtained at the cost of *doubling* the total amount of free alkali originally present, a second equivalent being actually introduced by the (supposed) ameliorating agent.

Besides processes for "refining" soaps during remelting, by removal of excess of alkali by means of the addition of suitable ingredients, many methods are in use for preparing fancy soaps of different kinds, by intermixing therewith small quantities of materials added for the purpose of communicating special characteristic qualities; and in many cases notable amounts of cheap ingredients are also intermixed for the purpose of increasing the bulk by addition of "filling." The various bodies thus added naturally fall into three classes, viz.: (1) substances which are added in small quantity, not as "filling," but in order to improve the quality, and which actually do produce that result to a greater or lesser extent, without introducing any serious counterbalancing injury to the product as a whole; (2) substances added in quantity as "filling," but not producing any serious injury by their own nature; and (3) bodies distinctly objectionable in their nature when intermixed with soaps intended for habitual, everyday use by the general public, and not under special medical advice.

Among bodies of the first class may be mentioned certain finely powdered roots, etc. (*e. g.*, *orris*), used as perfuming agents, *vaseline*, *spermaceti*, *beeswax*, *ozokerite*, and analogous substances employed for the purpose of developing a bland, emollient kind of feeling in use. *Glycerin*, either in the quantity formed by the natural saponification of glycerides (as in the cold process), or added in addition to a further extent, may also be fairly ranked among these substances, *i. e.*, when employed in a sufficiently pure state.

Among the substances of the second class which can hardly be regarded as absolutely injurious, although their presence is at least of doubtful benefit, may be noticed the following, when added in such quantities as to act as "filling" or cheapening agents: *Oatmeal, flour, gluten, gelatin, dextrin, bran, starches* of various kinds, powdered *steatite*, and *French chalk*,* *china clay, pipe clay*, and *fuller's earth*; and purified *petroleum* (in transparent soaps).

The following substances may be named as materials belonging to the third class, *i. e.*, substances used for incorporation with so-called "toilet" soaps, the absence of which would be far preferable to their presence, no benefit of any kind, but distinctly the reverse, accruing to a tender skin from their employment: *Sawdust*, and *woody tissues* not in impalpable powder, *sand*, *pumice stone*, and *gritty matters* of all kinds, unrefined *petroleum and shale oils*, crude *coal and wood tars*, *naphthaline*, *creosote*, and analogous *coal tar oils*,* and, *par excellence*, *alkaline salts* of all kinds, especially *pearlash*, *soda crystals*, and *silicate of soda*. Any large admixture of neutral salts, such as sulphates and chlorides (several per cents.), added as hardening agents to hide watering, is also to be deprecated, the more so as they usually accompany the use of inferior materials in the first place.

Besides the substances above named, various other ingredients belonging to one or other of the three classes have from time to time been brought forward, and sometimes repatented more than once. Among such bodies may be mentioned free ammonia solution, added for the purpose of increasing detergence without correspondingly increasing the corrosive action on the skin that alkalies and alkaline salts (even borax) tend to exert. The difficulty experienced in preventing the almost complete loss of the ammonia by evaporation on keeping a while has hitherto prevented these soaps from being largely used; one patentee attempts to get over the difficulty by coating the ammoniated soap tablets "with a case of suitable soap or washing compound or soluble or other substance," while another is under the impression that mixing oil of turpentine with the mass will prevent the evaporation of the ammonia.

* Sometimes these materials are stirred up with water to a thin paste, which is run into the remelted soap and well incorporated by crutching, the final product being sold to a credulous public as "milk" soap! When dissolved in hot water, and the liquid allowed to stand, the white, clayey intermixed matter subsides, and is readily discernible.

* A large variety of "medicated" soaps, containing more or less considerable quantities of substances referable to the disinfectant class, are in the market. In a large number of cases, the amount of medicating material thus incorporated (thymol, terebene, eucalyptus oil, oxidized turpentine oils, camphor, and similar materials) is so small relatively to the mass of soap as to have little more influence on the qualities of the whole than the essential oils, etc., used as perfumes. Such soaps, when otherwise of good quality (by no means invariably the case), may generally be used for toilet purposes with safety, even by persons possessing pretty sensitive skins; but when any considerable quantity of a powerful agent (such as carbolic acid, or coal-tar oils containing it) is present, such soaps *should only be used by tender-skinned individuals under medical advice*. In certain cases, the impregnation of soap with drugs (such as mercurial preparations) forms a most convenient way of exhibiting the latter to patients requiring them; on the other hand, various soaps exist which claim to contain curative agents not really present at all, *e. g.*, *sulphur*. The use of powerful disinfecting soaps in sick chambers and for nurses, for washing linen, furniture, etc., in case of illness, and similar purposes, is, of course, an entirely different thing from the habitual employment under ordinary conditions of such soaps for the usual personal ablutions; but it may well be doubted, even in these cases, whether it would not be preferable to use ordinary soap, and simply dissolve the disinfecting material to the required extent in the water employed.

NOBERT'S RULING MACHINE.

AT a recent meeting of the Royal Microscopical Society, the original ruling machine with which the late Herr F. A. Nobert ruled his famous test-plate and diffraction gratings was exhibited and described by Mr. J. Mayall, Jr. Mr. Mayall said the foundation of the machine was a dividing engine calculated to produce parallel divisions far finer than could be marked by any ruling point yet discovered. The division-plate had 20 circles of "dots," and these divisions were supplemented by extremely fine graduations on two bands of silver embedded near the edge, which were viewed by means of two compound microscopes, each provided with eyepiece screw micrometers of special construction. The movement of rotation was effected by a tangent screw, controlled by a milled head about 4 in. in diameter, a graduated drum showing the amount of motion.

The method employed by Herr Nobert to obtain the minute divisions of his test-plates (ranging from $\frac{1}{1000}$ to $\frac{1}{30000}$ of a Paris line) was to convert the radius of the division plate into a lever to move the glass plate on which the rulings were made at right angles to the motion of the ruling point. For this purpose he attached to the center of the division plate a bent arm on which slided a bar of silver having at one end a finely polished steel point which could be adjusted by a scale and vernier so as to project more or less beyond the center of the division plate or axis of rotation.

The radius of the division plate thus became the long arm of the lever, while the radius of the projection of the polished steel point beyond the axis of rotation formed the short arm, the center of the division plate being the fulcrum. The motion of the short arm of the lever was communicated by contact with an agate plate fixed beneath a polished steel cylinder adjusted to slide at right angles to the movement of the ruling point in V-shaped bearings of agate. The steel cylinder carried a circular metal table, on which the glass plate to be ruled was fixed by wax and clamps. The motion of the lever arms was, of course, in arc, and hence the divisions would not be strictly equidistant unless compensation were made for the difference in length of the arc and its sine; but, since the actual space included between the first and last lines of Herr Nobert's test-plates hardly exceeded $\frac{1}{50}$ of an inch, this difference would be inappreciable.

The arrangement for carrying the diamond point was, he believed, wholly designed by Herr Nobert, and was a most ingenious combination of mechanism. The questions to be solved were (1) to provide means to adjust a diamond edge to any angle within required limits; (2) to balance it truly, so that the weight pressure for ruling might be perfectly controlled; (3) to raise and lower it strictly in one plane—that is to say, mechanically free from lateral play, so that the consecutive divisions of the ruling depended solely on the motion imparted to the glass plate by the dividing engine; (4) to cause the diamond to oscillate freely in one plane; (5) to control the length of the lines to be ruled; (6) to connect the whole with mechanism to insure an even rate of speed in the ruling movement of the diamond.

These matters have been worked out by Herr Nobert with extraordinary perseverance, as evidenced by the elaboration of the adjustments. The success of his efforts must be estimated by those who were familiar with his ruled test-plates, and who had compared them with others. Mr. Mayall then explained the modifications Herr Nobert had devised to secure practically perfect equidistance of the rulings for diffraction gratings and micrometers where the breadth of space covered by the lines was so large that the lever motion in arc of the dividing engine would have introduced errors in the equality of the divisions. He then referred briefly to the preparation of the glass plates for the rulings, which he said were of specially "mild" composition.

He believed that Herr Nobert's earlier rulings were upon artificially prepared surfaces on the slips, and that later on (about 1860) he came to the conclusion that the melted surface of cover glass was better for his test-plates. Subsequently, Dr. Hugo Schröder instructed him in a method of polishing the "mild" glass which induced him to revert to artificial surfaces again. The later test-plates were probably all ruled on the prepared "mild" glass, thinned down to suit high power objectives. Mr. Mayall said he must defer his remarks on the diamond points until the next meeting; he mentioned, however, that the ten diamonds which accompanied the machine presented varieties of preparation. Some had two worked surfaces meeting in a knife edge; others one worked surface and one surface of fracture; others had two surfaces of fracture.

By reference to Herr Nobert's memorandum book, Mr. Mayall said he hoped to be able to explain the character of the diamonds which were noted upon as being successful. As to the means employed by Herr Nobert to regulate the pressure of the diamond, the memoranda showed that with a 30 band plate he began the first band of lines ($\frac{1}{1000}$ of a Paris line) with a weight of 30 grammes, and reduced the weight for each successive band until he arrived at about 3 grammes for the highest band ($\frac{1}{3000}$ of a Paris line). In conclusion, Mr. Mayall said it was abundantly proved by Herr Nobert's work that the perfection of the mechanical part of the dividing engine was not the only difficulty which he had understood and conquered. There was a still greater difficulty which he had understood, and which he had met with a success that gave him pre-eminence in this department of micro-physics, and that was the preparation of the diamond ruling points.

THE RECOVERY OF RESIDUALS FROM FURNACE GASES.

IN these days of keen competition and extremely low prices throughout all branches of the iron trade, anything that tends toward the economical production, either in improved methods of manufacture or in the saving of what has hitherto been waste material, is a matter of considerable importance. It will therefore be of interest to direct attention to what is at present being done by Messrs. Robert Heath and Sons at their Norton Works, Staffordshire, with the object of utilizing the residuals from the gases produced in their furnaces. For a long time past the gases from the furnaces have in nearly all large works been utilized as fuel for the heating of boilers, but comparatively little attention has been paid to the utilization of the residuals that can be obtained from the gases. In Scotland, plant has been put down for this purpose, but in England, Messrs. Robert Heath and Sons are the first who have as yet attempted this means of economizing all the products from the coal. It is, however, an important fact, that should be borne in mind by steel and iron masters generally, that whenever coal is used in their furnaces, there are residuals from the gases produced, the recovery of which may form a considerable item in reducing the actual cost of working. The plant which has been put down at the Norton Works has been designed and patented by Mr. John Dempster, of the firm of Robert and John Dempster, gas engineers, Newton Heath, near Manchester, and is now being completed under his direct supervision. The apparatus is somewhat similar to that used in ordinary coal-gas works, but for the special object for which it has been designed, several entirely new features have been introduced. A very powerful condenser of 200 wrought-iron tubes, 40 ft. long, fixed vertically, has cold water flowing down the outside of each pipe. These pipes are fixed in ten rows of twenty each, and are arranged with valves at the end of each row, so that any row can be shut off and cleaned. The gases are drawn from the furnaces, and forced through the apparatus by four exhausters, each one arranged to be shut off by valves when required. After leaving the exhausters, the gases pass through four washers specially designed for the object in view. The gas then goes forward through four scrubbers of large diameter 100 ft. in height. These scrubbers form a square, and are connected to each other so as to present a substantial structure against wind pressure. They are filled with material exposing a large surface, especially arranged for the purpose, and there is a separate pump to each scrubber. These pumps maintain a constant flow of ammoniacal liquor through each scrubber, except the last, and through this a stream of pure water is flushed to absorb the last traces of ammonia. These scrubbers are also all arranged with valves, so that any one can be put out of action, and in the apparatus throughout precautions have been taken against accidents from explosions by having escape valves fixed so that any sudden rush of gas would find easy exit. The apparatus also embraces stills for the manufacture of sulphate of ammonia, etc. One of the objects which Mr. John Dempster has had to keep specially in view has been that in recovering the residuals there shall be no waste of gas or any deterioration of its heating power, as the whole of the gases from the furnaces is utilized for raising steam for the blast engines, forges, and pits owned by Messrs. Heath. This he hopes to accomplish without reducing the quantity or quality in the slightest, as even the distillation of the ammoniacal liquor will be effected without additional fuel or gas being required. The neighborhood of these works would seem to be conspicuous for its progressive spirit, as the first works on a large scale to carbonize coal, for the residuals only, were erected within a mile of these furnaces for the Staffordshire Coal Carbonizing Company. These were also designed by Mr. John Dempster, and it may be added that he has since designed works capable of carbonizing 3,700 tons of coal per week for the same purpose, which are now in practical operation.—*Coll. Guardian.*

ADULTERATION of cane sugar by glucose is easy to detect by the microscope; cane sugar presents distinct, fine, clear crystals, like rock candy, while glucose appears dull and opaque, crumbling like tallow.

APPARATUS FOR EXTRACTING BEET JUICE BY DIFFUSION.

THE diffusion process of extracting beet juice is based upon the phenomenon of dialysis or osmosis, which occurs between the water and saccharine juice. The water enters the cellular tissue of the chopped-up beet, and drives the saccharine liquid out. There is thus obtained a purer juice than that given by the system of rasping and mechanical pressure. Now that the apparatus for it have been improved by our manufacturers, this process is being substituted for the old methods.

Having stated the principle upon which the process is based, we can proceed to describe, in its entirety and in detail, the improved plant illustrated in the accompanying engravings.

As may be seen in Figs. 1 and 2, the plant consists of 14 diffusion vessels, D, arranged in a circle around the root cutters, R. These diffusers have a capacity of 22 gallons, and the number of them permits of obtaining a more perfect exhaustion and a denser juice than with the ten or twelve vessels usually employed.

These vessels are sufficiently distant from one another to leave a passageway between them, and they, as well as the heaters, C, are connected above by an iron framework. This latter is formed of radiating T-irons that rest in the center upon a pillar, A, and at the outer extremity upon light supports, *a*.

The upper floor contains the root cutters and a chute, R, which is capable of revolving so as to present its extremity to each diffuser in succession. On this same floor also there are two presses, P and P^1, whose charging screw, B, receives from the lift, E, the spent slices of beet that drop from the diffusers into the masonry receiver, A^1.

In the building to the right are located the apparatus for carrying and washing the beets. These latter are emptied into the hopper, F, from whence they are taken by the screw lift, F^1, and carried to the washer, G. From the latter they pass to the second washer, G^1, which finally empties them upon an inclined grating, *g*, which directs them into the trough of a rinsing lift, H, from whence they pass into the large lift, E^1, which, through the chute, E^2, feeds the root cutters.

Finally, two ganging backs, T, receive the juice that comes from the diffusers.

Washing.—The washing room contains a screw lift, F^1, formed of an iron plate helix mounted upon a cast iron shaft, and actuated above through a pair of bevel wheels and the pulleys, *f*. Its lower part rests upon a step bearing, and is provided with a pivot and oil cup. A stream of water, flowing constantly at the upper part of the helix, wets the beets and dissolves the adhering earth.

A sloping chute, f^1 (Fig. 1), arranged at the top of the jacket of the helix, empties the beets into the first washer, G. This latter, as well as its mate, G^1, consists of a double-bottomed iron plate vat 10 feet in length by 4 in width.

The upper bottom contains apertures, and upon it rest the beets. These latter are stirred up and pushed toward the end by a cast iron shaft, g^1, provided with wooden arms, g^2, arranged spirally. The three last arms are placed very near one another, so as to lift the beets and throw them out. The mud derived from the beets passes through the apertures to the lower bottom, which, being inclined, leads them to the sink trap, G^2, which is opened from time to time by acting upon a lever.

Upon making their exit from the second washer, the beets slide over the grating, *g* (Fig. 2), into the hopper, H, of the rinsing lift shown in detail in Figs. 5 and 6.

The Rinsing Lift.—This apparatus is formed of a box, H, 4½ feet in length by 2½ in width, which rests upon two cast iron supports, and in which revolves an iron shaft that carries an iron plate helix, *h*, provided at its lower part with four iron arms, *h*. In the upper part of H, and also in the first four spirals of the helix, there is a number of small apertures. The box is constantly fed with clean water at the upper part, while the dirty water flows off at the lower. The beets that fall into this apparatus are stirred up by the arms, and float to the surface of the water, while the stones that may have chanced to enter fall to the bottom, from whence they are removed through the aperture, h^2. The floating beets are carried along by the helix, whose four lower spirals permit them to drain as they move forward.

This apparatus is actuated by a pair of bevel wheels, j^3, and two pulleys. The beets on making their exit from it are carried by a

Bucket Chain to the root cutters. This chain, which is shown in detail in Figs. 7 to 9, is 37 feet in length from axis to axis of the sprocket wheels, *e*, around which it runs. The links carry buckets, e^1, which are attached to it by steel hooks, and which are provided with riveted angle irons, that slide between T-iron guides, and that are fixed in pairs to the interior of the carriage formed by the vertical wooden uprights, E, as shown in Fig. 9.

The buckets are perforated so as to allow of the escape of the water carried along. The upper pulley receives motion through the intermedium of a wheel and pinion, E^2 (Fig. 8), whose axle carries fast and loose pulleys. The lower pulley is keyed to a shaft that runs in bearings which are adjusted in the slides of two cast iron pieces, e^2 (Figs. 7 and 9). These are provided with screws that permit of sliding the bearings, and of thus giving the chain the tension desired.

When the buckets reach the upper part of the elevator, they run over the pulley and empty the beets that they contain into the inclined chute, E^2, which carries them to the hopper of the

Root Cutters.—These apparatus, shown in Figs. 10–16, consist of a stationary cast iron disk, I, which carries a semicircular iron plate hopper, I^1, into which the chute, E^2, empties the beets. This disk is fixed to a cast iron vessel, R, supported by four legs, and is surmounted by a hollow column, R^1, which is cast in a piece with an arm for supporting the horizontal driving shaft. The center of this column is provided above and below with two bronze bushes in which revolves a vertical shaft, J^1, to the base of which is keyed a revolving disk, J, provided with knives. A pair of bevel wheels connects the vertical with the horizontal shaft that carries the two driving pulleys, K^1. The upper part of the column is provided with a bronze box, *i* (Fig. 10), forming an oil cup. To the bottom of this is fixed a cast iron ring, against which bears another ring that is attached to a nut, i^1, screwed upon the shaft. These two rings form a well lubricated annular pivot. The nut, i^1, of the vertical shaft serves to regulate the height of the disk that carries the knives. The revolving disk, J, contains ten rectangular cavities, *j*, into which are set the knife-carriers, j^1. In the stationary disk, at the same distance from its center as the cavities for the knife-carriers, there is a semicircular aperture surmounted by an iron plate hopper, I^1, and divided into four compartments by three slanting partitions (Fig. 11), to each of which is fixed a plate, i^2 (Fig. 12), that serves as a bearing point for the beets when attacked by the knives. The type of knife adopted is shown in Figs. 12 and 13. The knives (*k*) are screwed to cast iron boxes, j^1, that fit so accurately into the cavities prepared for them that there is no need of fastening them. This permits of changing them more easily when they get dull.

Each box contains two of these knives, which present to the beet a cutting surface of eleven inches. The length of the blade is regulated at will by means of a piece of steel, k^1, fixed to the knife carrier by screws, *l* (Fig, 12).

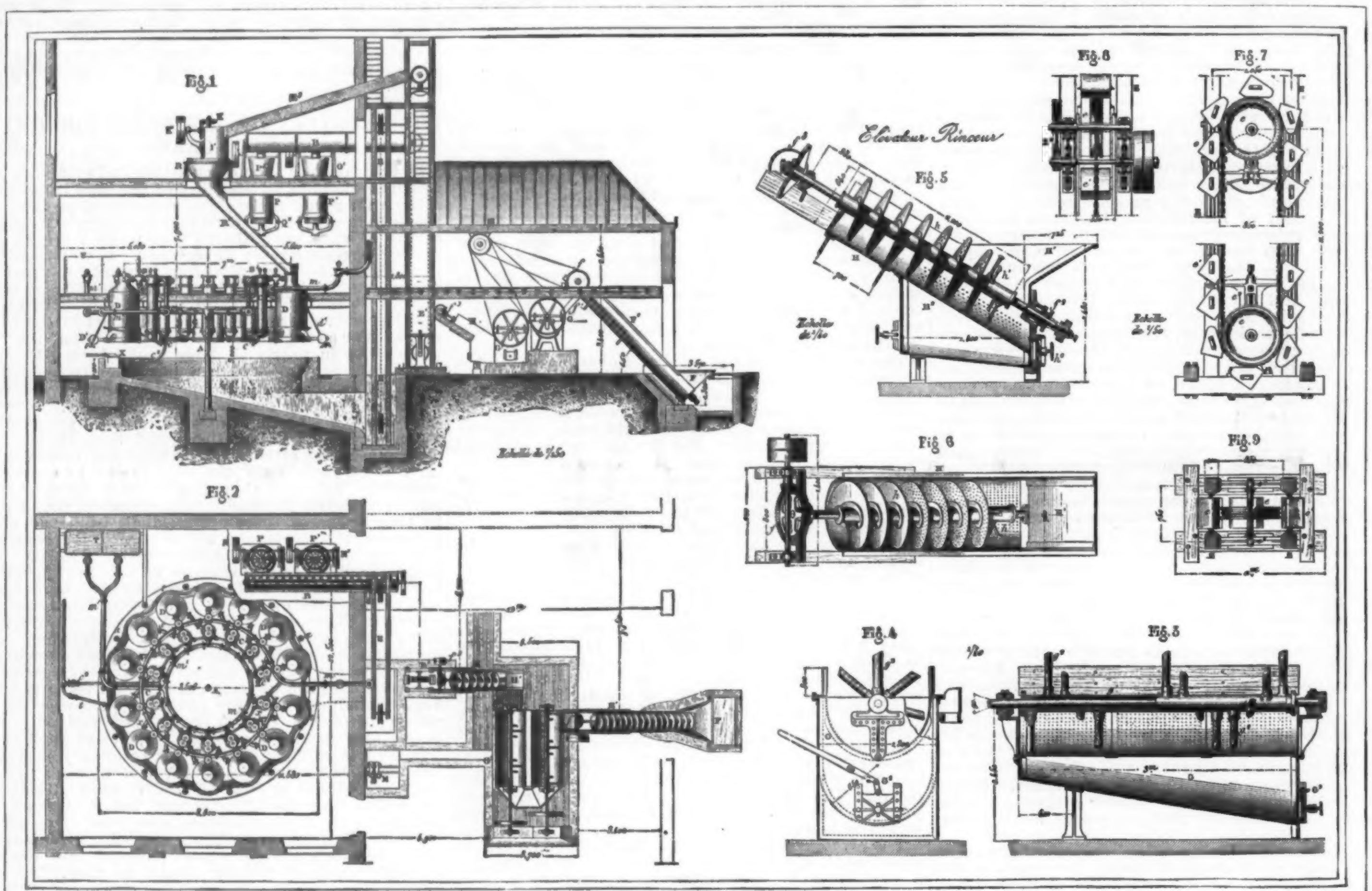
The funnel, R, receives the slices and leads them to the chute, R′, which empties them into one or the other of the diffusers. This chute is provided with an angle iron, *r*, which is supported beneath by four rollers, *l* (Figs. 10, 14, and 15), and above by four rollers, l^2, whose axes are carried by the part, R.

The Diffusers.—These consist (Figs. 17 and 18) of an iron plate cylinder, D, of four feet internal diameter, surmounted by a conical cast iron dome. The bottom, which is in the form of a truncated cone, is cast in a piece with hinges for the door through which the sliced beets are removed. This door, which is of cast iron, and very strong, is 3¾ feet in external diameter, covers an orifice 3½ feet in diameter, and is provided with a counterpoise, D′. It oscillates around the axis, *d*, under the action of the screw, *d′*, whose nut is fixed upon the lever of the counterpoise. This latter is maneuvered by means of a hand wheel. A double nut, d^2 moved by a lever, L, within reach of the workman completes the closing device.

The joint between the door and the part that serves as a seat for it is formed by a rubber ring, *s*, filled with water, and set into a groove in the cast iron base. When the door has been closed, a pressure of steam is exerted, through the cock, *s*, upon the water in the ring, and the latter then expands and makes the joint perfectly tight. A perforated plate, D^2 (Fig. 17), is fixed to the door, in order to strain the juice circulating in the apparatus, and to prevent the slices from passing with the juices into the circulating pipes, *x*, which, through the elbows, *x′* and x^2, connect the base of each diffuser with that of each heater. The mouth is provided with a cast iron cap, D^3, which, with its stirrup, pivots around an axle. Its closing is effected by a screw and handwheel, d^3.

The joint is formed by a rubber ring set into a groove. The cap is provided with a cock, s^2, that allows the air to escape while the juice is entering the diffuser. A perforated disk, d^4, is placed under the cap, in order to prevent the sliced beets from entering the circulating pipes when, at the beginning of operations, the juice is being let into the bottom of the diffuser.

The Heaters.—Each diffuser is connected with a heater that consists of a cast iron cylinder, C, provided internally with a copper worm having a heating surface of 114 square feet. This worm is attached to the upper part of the cylinder, near the steam cock, *c* (Fig. 20). Its lower extremity bends horizontally and enters a stuffing box (Fig. 17) that allows of expansion without the escape of juice or steam. To this box is affixed a



FIGS. 1 AND 2.—Elevation and Plan of the Plant. FIGS. 3 AND 4.—Beet Washer. FIGS. 5 AND 6.—Rinsing Lift. FIGS. 7-9.—Details of Chain and Buckets.

DUJARDIN'S DIFFUSION APPARATUS.

valve, c^1, which is provided with a sample cock, and is connected with a conduit that unites, through the pipe, c^2 (Figs. 1 and 2), all the returns of water in a single automatic purging apparatus, X (Fig. 1).

Each heater is surmounted by a thalpotasimeter, c^3 (Fig. 20), with a dial, which shows the temperature of the juice within. The pipes in which the water and juice circulate are of cast iron, and are of 5⅛ inches internal diameter. Three valves, S, S', and S^2, in a line above each diffuser, serve to regulate the flow of the juice and water in the apparatus. The first of these, S, serves for introducing the water circulating in the pipe, m, under pressure into the diffuser that is being emptied. The second, S', belongs to the circulation, and remains constantly open between the diffusers. The third, S^2, lets out the strong juice, and puts the diffuser whence the latter is issuing in communication with the pipe, m', which leads it to the gauging backs, T. These latter (Fig. 2) are located on the same floor with the diffusers. They are provided with graduated scales to show how full they are, and with cocks that permit of sending the juice to the apparatus in which it is to be treated with boneblack.

The exhausted slices of beets, when the bottom of the diffuser is opened, fall into a large masonry funnel, and are carried along by water to the lower extremity of the chain, E, which raises them up to the presses. The waste water passes through a perforated plate of iron that forms one of the sides of the trough that the base of the lift enters, and is forced by a pump, M (Fig. 2), to the beet washers.

The Presses.—The presses, two in number, are of the Bergreen pattern. One of them is shown in section in Fig. 22. It consists of an iron plate cylinder, P, filled with sliced beets while another is being emptied, the latter will be receiving the direct pressure of the water, its valve being open in order to allow the latter to enter through the pipe, m. The valve, S^1, is closed, and all the other diffusers have their valves closed, save those (S^1) that set up communication with the heaters. A current is thus established between the water back and one of the diffusers (which we shall designate as No. 1), through its upper and lower part, by means of the elbow, x, at the upper part of No. 2, and passes through heater No. 1 and the valve, S^1, of No. 2. The same is the case with diffusers Nos. 3 to 12, which latter communicates with the upper part of No. 13 through its heater and the valve of No. 13.

If all the valves of No. 14 are closed, there will be no circulation, for want of an exit. In this case, the valve of one of the gauging backs, T, is opened, after the juice valve, S^2, has been opened, and the juice will then flow from No. 14 through the pipe, m'. After a certain quantity of the juice has been extracted, the valve of the gauging back is closed, as is also that of diffuser No. 1, which will be thus isolated. After this the pressure is transferred from No. 1 to No. 2 by opening the water valve No. 2. During this time diffuser No. 14 has been filled with fresh slices, and we now proceed to introduce juice at the bottom, since the introduction of it at the top would produce a subsidence that would interfere with the operation of the apparatus. To effect such introduction, it is only necessary to open the juice valve, S' (Fig. 17), of No. 1, when the juice will, through it, enter heater No. 14, which communicates with diffuser No. 14 through the lower part, x^2, x, x'. During the charging of No. 14 with juice, the air cock, s^2, is opened, as is also the water cock, y (Fig. 18), at the

THE TREATMENT OF SEDIMENT-CARRYING MOUNTAIN STREAMS IN EUROPE, AND ITS APPLICATION TO CALIFORNIA.*

By GEO. J. SPECHT, M. Tech. Soc.

Introductory Remarks.—The debris question, so important to the interests of this State, is full of interesting features. It is of such intricate and complicate nature that only the most careful and impartial investigations of all the conditions bearing upon it can bring about its successful solution. The desire to contribute a small share to such has moved the writer to investigate what has been done in reference to sediment-carrying rivers, torrential streams, etc., in other parts of the world. The Alps in the southern and central part of Europe afford the best opportunity to study this question, as they have a great many such water-courses, which have damaged and partially continue to destroy the valleys by raising by the river bed and destroying adjoining agricultural lands by erosion or filling in. Certain portions of these, however, have been very successfully improved by comparatively simple and inexpensive means. The source of the detritus there is natural wash, and in no case hydraulic mining.

In California the conditions are somewhat different, since the natural as well as the artificial source of the detritus must be considered. Appreciating fully this difference, it is nevertheless apparent that a study of the works of European engineers, in reference to the permanent improvement of sediment-carrying water-courses, cannot fail to be of service to those engaged in the solution of this question in California. Taking advantage of this experience, and modifying their

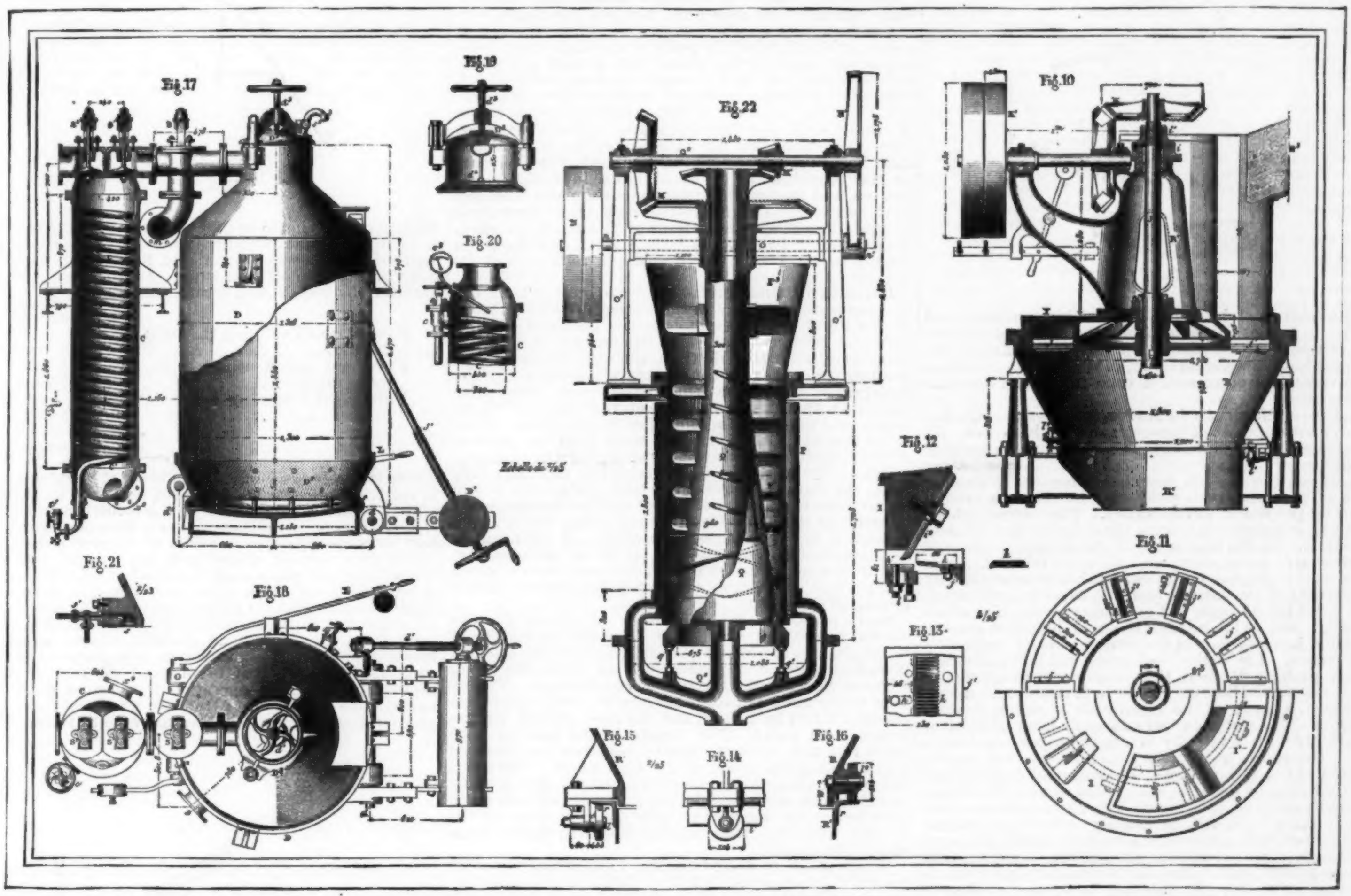


FIG. 10.—Root Cutter. FIG. 11.—Plan of the same. FIGS. 12 AND 13.—Knives. FIGS. 14-16.—Details of Rollers. FIG. 17.—Heater and Diffuser. FIG. 18.—The same seen from above. FIGS. 19-21.—Details of the same. FIG. 22.—Press.

DUJARDIN'S DIFFUSION APPARATUS.

which incloses another, P^1, containing rectangular apertures and surmounted by a hopper, P^2, in the interior of which revolve two superposed truncated cones, Q and Q'. The latter of these, Q', is cast in a piece with spirally arranged arms, which are so inclined as to compress the slices and push them toward the bottom. On a line with this, the lower cone, Q (which is cast in a piece with a helix), revolves in an opposite direction.

This double revolution in opposite directions is produced by two bevel wheels, M and M^1, driven by the shaft, n, which is provided with a pulley, N, and a pinion, n^1, which gears with the wheel, N^1. To this effect, the upper cone, Q^1, is provided with a hollow cylindrical part that passes through a bush in the cross piece, O, which connects the sides, O^1, that support the shaft, O^2; and this cylinder carries the wheel, M, through which motion is communicated to it. The same is the case with the lower cone, Q, which is prolonged by a hollow axle that passes through the interior of the first, and receives at its upper part the wheel, M^1, whose pinion, keyed in an opposite direction to that of the wheel, M, causes the cone to revolve in a direction contrary to that of the other.

The slices make their exit at the lower part of the press through an annular orifice whose diameter is regulated by a ring, q, and screws, q^1. It is upon the diameter of this passage that depends the pressure exerted by the helices on the slices. The liquid that traverses the perforated cylinder is received in the jacket, P, and flows externally through elbows that are connected by the pipes, Q^2.

Operation of the Apparatus.—If we suppose the plant in full operation, that is, that one diffuser is being bottom of the same diffuser, in order to destroy all internal pressure; and after this, the lower door being opened, the slices will be carried along by the surrounding water to the cistern of the chain, E. Then a washing is effected by opening the water valve, the lower door is closed, and fresh slices are put in.

During this interval, the liquid has reached the level of the mouth of diffuser No. 14, which we close, and at the same time open the air cock, s^2, on its cover, D^2. When the liquid begins to issue through this cock, we close the latter, as also the juice valve, S^2, of No. 1, and open valve, S^1, of No. 14. The current, which was before flowing upward, now becomes reversed, and flows downward. Then, by opening the valve of the gauging back, we extract a new quantity of juice, and afterward produce a pressure upon No. 2, as we did before upon No. 1; and the operation continues without interruption.

In order to set the plant in operation, a certain number of the diffusers are filled with water, and the steam cocks, c, of the heaters are opened. When the water has reached the requisite temperature, the following diffuser is filled with sliced beets, and we proceed as if the plant were in full operation, removing no juice until it has reached the desired aerometric degree.—*Publication Industrielle.*

The Angler mentions a mixture which is recommended for keeping off mosquitoes and gnats, which abound in moist districts. It consists of three parts olive oil, two parts oil of pennyroyal, one part glycerine, and one part of ammonia. It is to be well shaken before applying to the face and hands, and it must not be allowed to get into the eyes.

measures according to local conditions, more satisfactory results will be obtained than if the same were ignored. No originality is claimed for that part of this paper, still the writer hopes that it will be agreeable to the members of the Technical Society, and will give rise to a thorough and careful discussion and investigation on the part of this society of one of the most important questions in California.

Characteristics of Torrential Streams.—Before entering upon an account of the remedies applied, it is necessary to look into the general nature of torrential streams.

1. *Origin.*—The constant influence of the atmosphere, the rains, snows, hail, and dews, and the changes of temperature, all affect the materials of which the mountains are composed, and cause a continuous disintegration of the surfaces, which are washed down subsequently by the falling rain. This occurs most rapidly there where the soil is not protected by vegetation. The flowing water cuts a channel in which the detritus is carried to the lower valleys. The disintegration and erosion progresses then more rapidly. The water undermines the slopes; these, losing their equilibrium, slide into the water-course, and are carried away by the water. The bed becomes wider and deeper, new tributaries are formed until a large number of them cover the whole watershed.

2. *Classification.*—The torrential streams can be classified conveniently as follows:

a. Simple Torrential Steams, having but one main gorge or valley into which a smaller or greater number of secondary tributaries issue.

* From Transactions of the Technical Society of the Pacific Coast. Read July 11, 1884.—*Eng. News.*

b. Compound Torrential Streams, which have two or more main gorges or valleys, or are composed of several simple torrential streams.

c. Fan-shaped Erosions on the slope of the mountains. Here one deep erosion is fed by a large number of smaller ones; they are generally dry, except during the rainy season.

3. *Subdivisions.*—To whatever class the torrents belong, they all show three or four distinct subdivisions:

a. Region of Erosion.—Collecting basin, A, B, C, in Fig. 1. This comprises the upper part of the watershed, where the water and the products of disintegration and decomposition are collected, and from which, both combined, are carried into, *b, region of transportation* (*a b* in Fig. 1), which serves as channel-way to transport the water and the detritus into the, *c, region of deposition* (*b c* in Fig. 1), which is raised continuously

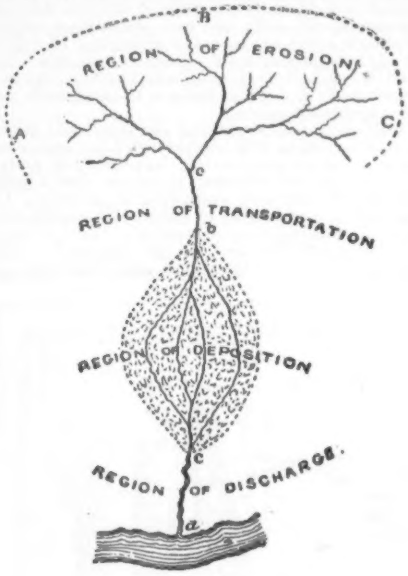


FIG. 1.

by the settling of detritus; *d, channel of discharge* (*c d* in Fig. 1), carries the water from the region of deposition, where it left its coarser detritus, to the main river. This section, however, is sometimes missing. All these subdivisions can occur several times in one and the same water-course.

4. *Action of the Water in Torrential Streams.*—During the dry season, most of these streams are harmless. As soon, however, as warm winds cause a sudden melting of the snow, cloud-bursts occur or a long-lasting rain sets in, the erosion becomes immense. A chaotic mass of debris, gravel, rocks, and bowlders is carried down by the water to the valley. The volume of the sediment is sometimes several times larger than that of the water. In the beginning all the different classes of detritus are carried along with the same velocity. Soon, however, the large detritus will attain a greater velocity on account of its volume, and will deposit itself wherever a sudden decrease of the grade occurs. The other material will lodge behind them, at first in a general disorder, but later on in the order of their respective dimensions. The region of deposit will them assume a *convex* profile. If, then, the volume and the power of the water should become greater, a reversed action commences, *i. e.*, that of the separation of different sized detritus. The water carries now each kind of detritus separately with a velocity inversely proportional to its size. The result is that the fine material will be deposited at the lower edge of the region of deposit, and the coarser at or near the apex of the same. The longitudinal profile of this region will then assume a *concave* form, *i. e.*, it will be steeper toward the source. This change from a convex to a concave profile will occur after each large rainstorm or melting of snow. The convex profile proves that the stream has just come to a comparative rest. In this way the region of deposit will always be replenished, its grade will constantly increase until finally all the material carried to it by the stream loses its equilibrium and is carried farther down the valley. The grade on which this will occur is called the "*profile of equalization*." Then only such masses of detritus are transported from the upper region as the region of transportation can carry away. This corresponds to a continuous transportation of detritus in both regions, necessitating cessation of the above mentioned increase in the grade of the region of deposit.

But this state is not a permanent one, for as soon as

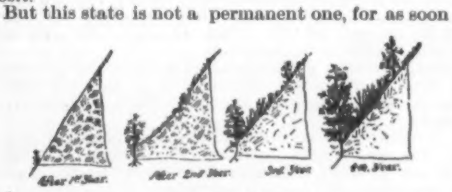


FIG. 2.

the water becomes clearer, and enters the region of deposit without being charged with detritus, then a similar process of erosion and transportation will take place, by which the surface of the region of deposit will be lowered more and more, and its slope will become gentler. This will continue as long as the grade is steep enough for the water to carry off the detritus. When, however, the limit of this is reached, and the transporting power of the water and the resistance of the river-bed balance each other, then the stream has "worked out," or becomes dormant; it will discharge only clear water, and the stream has adopted its final profile, the "*profile of equilibrium*." The profile of the region of transportation is always a concave curve at its lower end. It may, however, have a profile which does not fit into such continuous curve. This is the case when the erosion has reached the bed rock at several points. Then smaller or larger falls are formed, which interrupt the regularity of the profile. Below and above such places the regular concave profile will exist.

Means of Improving Mountain Streams.—In order to improve torrential streams in a permanent manner, it is necessary to determine:

1. How the formation of detritus can be prevented, or at least be decreased ?

2. How the detritus can be stored near its sources ?

The leading principle of any improvement is to attack the evil at its very source. Small slides and erosions, in their first state of formation, can be stopped easily at little cost; but if allowed to attain larger dimensions, they become rapidly more powerful, and require much more extensive and costly works.

The improvements requisite are—

1. Such as will prevent the sudden and rapid collection of larger quantities of rain water. This is accomplished by the planting of forests and the raising of grass and underbrush near the sources of the water-courses. Vegetation protects the soil against the mechanical effects of the rain; the roots bind the soil together, and the fallen leaves and the grasses retard the flow of the rain water; the plants absorb the same, and store it for a continuous and regular supply of the springs and water-courses. This will prevent the sudden rises of the rivers.

2. The protection of the shores against undermining, and the bed against erosion. This is principally done by the erection of "Thalsperren." The German word for these structures has been retained, as it is more significant and comprehensive than the English expression "restraining wall." It includes works that are not walls, but have the same duty, but in a less degree.*

A thalsperre is a structure erected across the bed of a stream, to diminish the grade of the same, and to decrease the power of the water; also to raise and thereby widen the bed, and to retain or store detritus. A distinction is made between "*dead and live thalsperren.*" The first are built of rock or timber, and the latter of hurdle work and fascines, made of green branches. The latter have the advantage over the former that their resisting power will increase from year to year, as the branches drive their roots into the river-bottom, and the growing twigs oppose greater obstacles to the water. The thalsperren of rock are either curved or straight. They can be built of either dry masonry, or of masonry in mortar, or both. Wooden thalsperren should be used only where stone or rock cannot be obtained economically.

If a series of thalsperren has been built so that the line connecting the foot of the upper one with the top of the lower one corresponds to the profile of equilibrium, *i. e.*, the grade on which the water is not able to carry away any more detritus, then it is evident that the detritus carried by the torrent will lodge above the thalsperren. If these thalsperren are sufficiently high, and the river bed has been widened by the deposits, and the water is compelled to run in the center of the thalweg, away from the shores, then the problem of the permanent improvement of the torrent is solved.

But as the grades of the torrents are generally very steep, the distance between two such thalsperren would be very short, and the number of thalsperren necessary to arrive at the desired result very great, which would involve a heavy expense. Therefore, all that can be accomplished is to create the profile of equalization, and then construct such other additional works, which will prevent the erosion of the deposits and the undermining of the shores.

Such works consist generally of strong hurdles erected lengthwise equidistant from the center line of the thalweg or the future river-bed, and of cross-hurdles, placed at regular distances, forming steps, the upper edges of which lie in the line of equalization. To prevent undermining of the cross-hurdles, they should not exceed 1·5 feet in height, and the toes should be protected with rocks. The brush in the hurdles soon takes root and sprouts, thereby securing the river-bed and breaking the power of the high water. The space between the longitudinal hurdles and the shores must be filled with earth, and be planted with willows set in rows under an angle of 45° with the center line of the torrent. Finally, trees driving deep and strong roots should be planted.

When stone is abundant, the hurdles are replaced by small thalsperren (2·3 feet high) of dry masonry (rustic thalsperren).

The works so far outlined have been employed successfully in France; they, however, refer principally to that class of mountain streams which derive their detritus solely by undermining the shores and eroding their own bed.

The other class of mountain streams, which receive their detritus from large accumulations of rocks, formed by the disintegration of the mountains or by glacial action, require additional works to neutralize the damaging influence of the continuous supply of material. These consist in the retention of the same near its source or, if this is not possible, in its storage near the foot of the mountains. The remedy in the first case is a restraining dam, a large thalsperre (in contradistinction to this kind, the previously mentioned thalsperren are called "consolidation thalsperren"), built up in the mountains, or, in the second case, a storage reservoir for the detritus on the talus of the torrent or at some other convenient place. As the restraining dams are built for the purpose to store as much detritus as possible, it is important that they should be built below places with gentle grades and of large lateral extent. They must be constructed so that they can be raised from time to time, by either putting a new section upon the thalsperre, continuing the same slope, or by building a new one a little back of it. This latter method has the advantage that by the succession of steps the power of the falling water is broken; also that in case of injury or break of one of the steps, the whole work is not endangered. The above-mentioned storage places have the purpose to receive all the detritus not restrained by the upper thalsperre. They consist of dams or levees, inclosing a larger or smaller area, with a waste-gate at the lower end, through which the clear water runs off. When the place is filled with detritus, trees are planted, and another storage place is prepared.

* The definition of the word "Thalsperre" is, a structure which closes up a valley. "Thal" is the German word for valley, and "sperren" to "close up."

Drainage of Sliding Slopes.—Permeable ground resting upon impermeable substrata frequently slides after a rainfall. To prevent this, the rain water should not be allowed to percolate the ground, which has been accomplished successfully by means of drainage channels or ditches. In one instance in France, four large ditches were excavated with a grade of 15 feet in 100 feet, into which a number of secondary drain ditches emptied. The main ditches were about 3·28 feet deep and 2·2 feet wide in the bottom. The bottom was well paved and the ditch then filled up, first with large stones, then with coarse gravel, and finally with fine gravel. The secondary drains were constructed similarly; they were 2·3 feet deep and 1·8 feet wide in the bottom.

These drainage works have been very successful when used in time, and great expense saved thereby.

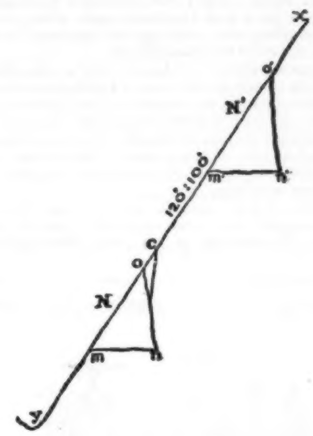


FIG. 3.

They should be made as near as possible to the sources in the high mountains where slides have caused small depressions, and which are liable to retain large portions of the rainfall and snow. In the perimeter of Sanieres the cost of such drains was:

		Secondary ditches.
Excava. per 1 running ft., main ditches	7 cts.	2 cts.
Pavement per 1 running ft., main ditches	3 cts.	1·5 cts.
Filling per 1 running ft., main ditches	1·6 cts.	5·5 cts.
	11·6 cts.	9·0 cts.

Similar drainage ditches have been used extensively in Austria, and, when constructed properly, have been always successful in preventing the formation of slides.

Protection of Very Steep Slopes.—To secure and protect very steep slopes, a series of narrow horizontal berms with vertical slopes and the bottom inclined toward the mountain along the side hill (Fig. 3) are cut. A laborer places plants upon the berms, *m, n*, so that their roots are about 4 inches distant from the outer edge; he then covers them with a little earth, which he takes from the slope, *o, t*. Another laborer prepares meanwhile the next higher berm, and throws the dirt excavated upon the first berm until the same is completely filled. This operation is repeated until the entire slope is secured. After two or three years the ground filled in is fit to be planted with fir trees. The

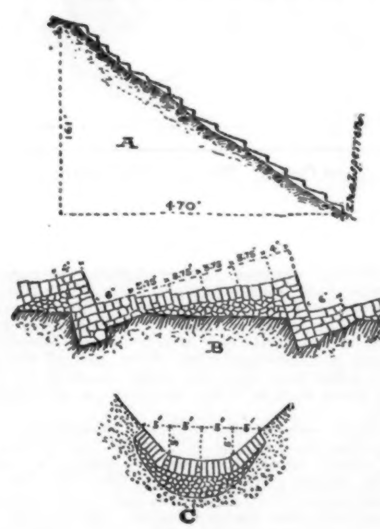


FIG. 4.

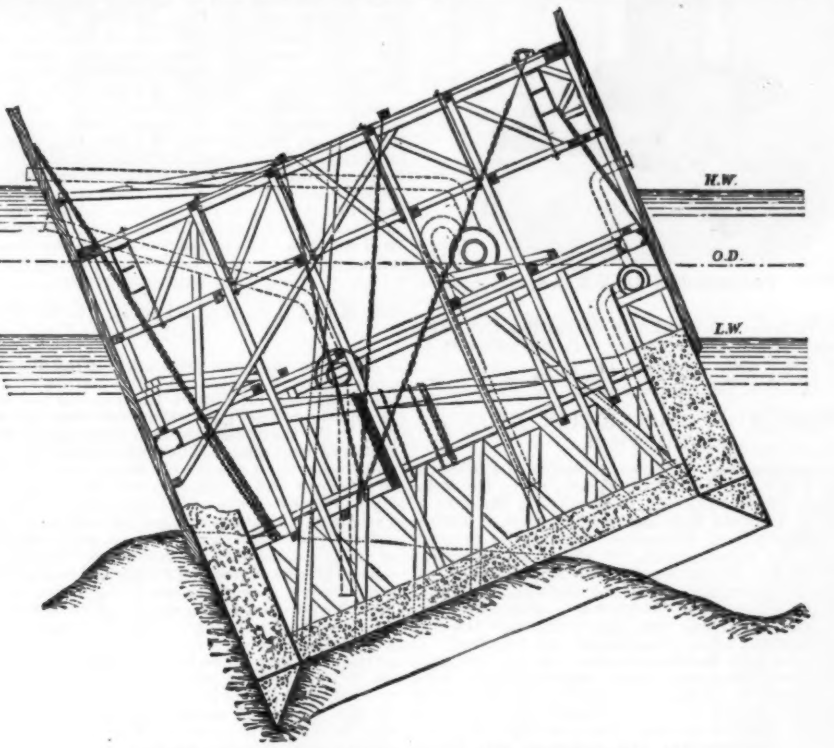
ground between the fir trees is used for grazing (Fig. 2). The cost of these berms, including planting, was 53 cents per 100 running feet.

Treatment of Very Steep Parts of the Stream.—Where the grade of the torrent is too steep to allow the erection of regular thalsperren, a construction was used which is shown in Fig. 4. The entire work was of dry masonry, with the exception of the thalsperre, which formed the base of the whole system and was built in mortar. In the case illustrated, the original grade of 37 feet in 100 feet was by this means reduced to 11 feet in 100 feet.

In those instances where one shore consisted of solid rock, and the other of loose material, spurs of dry masonry were built, by which the current was forced over to the solid rocky shore.

THE FORTH BRIDGE.

IT will be remembered that during the last winter a mishap occurred to the large caisson which will occupy the northwestern corner of the Queensferry main pier of the Forth Bridge. It had been launched, and towed successfully into position, but some short time afterward it became flooded, and partially sank, sliding forward at the same time until it took up a tilted position in the bed of the river. The displacement was about 15 ft., and the angle of slope 25 deg. To remove this enormous mass, which weighs about 4,000 tons, and is 70 ft. in diameter, has been a work of considerable difficulty. At first it was thought that it could be raised by adding plating to the submerged side until it was clear of the water; and after the interior had been properly strutted, by pumping out the water it was hoped that the caisson would be floated. This method, however, did not prove successful, as, in the course of pumping out the caisson, it gave way in a weak place. It was then determined to encase the caisson in a complete system of timbering, while the interior was carefully strutted throughout. When this had been completed, the water was pumped out, and the caisson floated. Owing to its tilted position, not only was the work of surrounding it with timber tubbing rendered very difficult, but the stresses on the strutting were much exaggerated. The determination of the stress involved problems of some intricacy, but the engineers left nothing to chance, but met every stress by a strut or tie of adequate strength. It was impossible to predict whether the caisson would gradually right itself as the water was pumped out, or whether the "stickage" of the mud filling the "working chamber" at the bottom would prevent the hydrostatic head taking effect upon the caisson till all the water was pumped out. It was necessary, therefore, to provide for the worst condition, and this implied an unbalanced pressure of 1,240 tons taking effect on the northern or deepest side of the caisson. To resist this a circular steel girder, with four raking steel struts, was provided, besides strong timber struts and chains, as shown in the engraving above. The timber sheathing consisted of whole balks beveled into each other, with strips of felt at the joints. To make a water-tight joint with the ironwork, recourse was had to grouting, oakum, and sailcloth. Two 18 in. Gwynne pumps fixed at different levels effectually dealt with the water inside the caisson, and a 12 in. mud-pump and Batho dredger removed enough of the bank on the south side to form a fairly level bed for the caisson when floated again into position. It proved that the tendency of the caisson was to right itself inch by inch daily if the water were kept some feet lower inside than outside. By encouraging this tendency its position was materially improved before the final operation of pumping out and floating took place. The designing and carrying out of the operations for raising the sunken caisson was the joint work of Messrs. Fowler and Baker, the engineers, and Mr. Phillips, one of the contractors. Great credit is due to the foremen and workmen employed, especially to the divers, who had to fix all the tubbing and heavy steel strutting, piece by piece, beneath the chilly waters of the Forth.—*Engineering*.



RIGHTING A CAISSON—FORTH BRIDGE.

TRIPLE COMPOUND ENGINES.

AT a recent meeting of the Institution of Naval Architects, London, Mr. A. E. Seaton read a paper which gave some recent experience with this class of machinery. This contribution comes opportunely at the present time when triple compound engines are attracting so much attention. Mr. Seaton commenced by describing four vessels recently built by the company he is connected with (Earle's Shipbuilding Company). Three of these ships were fitted with engines having cylinders 25 in. and 50 in. in diameter and 45 in. stroke, steam being supplied, in each case, at 90 lb. pressure from one double-ended boiler 13 ft. 9 in. in diameter by 15 ft. long, having a total heating surface of 2,310 square feet. The fourth boat had a triple compound engine with cylinders 21 in., 32 in., and 56 in. in diameter by 36 in. stroke, the high pressure cylinder being placed over the medium cylinder. In other respects these engines were made as nearly as possible like those already referred to. Steam at 110 lb. pressure was supplied from a double-ended boiler 12 ft. 9 in. in diameter and 15 ft. long, having a total heating surface of 2,270 square feet, and identical in design with the boilers of the other vessels. The propellers were also alike and the ships were alike, so that a fair comparison could be made.

One of the ships fitted with the ordinary compound engines was named the Kovno, that with the triple compound engines the Draco. Their dimensions were as follows:

	Ft.	In.
Length between perpendiculars.......	270	0
Breadth..........	34	0
Depth of hold..........	18	3
Gross tons register..........	1,700 tons.	

They were ordinary cargo boats built of steel, having a raised quarter deck and long bridge amidships. The Kovno was loaded with 2,400 tons dead weight, and sailed in January, 1883, for Buenos Ayres; and the Draco, having on board 2,425 tons dead weight, was dispatched in the following March to Bombay, the distance in both cases being about 6,400 miles. The ships were ordered to steam about the same speed, and in order to accomplish this it had been found by experience that a consumption of about 12 tons in the case of the Kovno was required, and 10 tons for the Draco. During the voyage each ship had average weather, and care was taken to get the best results. The average speed of the Draco was 8·625 knots, the engines making 57·5 revolutions, while the Kovno did 8·1 knots with 55·5 revolutions. The coal was ordinary South Yorkshire, and the indicated horse power in each case about 600. The total coal burnt on the Draco was 326 tons, while the Kovno consumed 405 tons. This shows an advantage to the triple compound system of 19·5 per cent. in fuel burnt with an increase of speed of 6·5 per cent. Taking the results of another of the vessels mentioned, the advantage was yet more strongly marked in favor of the triple compound engines.

Further results were obtained by means of the Yeddo, another vessel belonging to the same owners, Messrs. T. Wilson, Sons & Co. She had been working with ordinary compound engines at a pressure of 70 lb., the shafting not being calculated for heavier work. As the boiler was within the limits required for 100 lb. pressure, a third cylinder was placed on the top of the original low-pressure cylinder, and the ship dispatched to Cronstadt. The consumption of fuel was reduced from 17 tons to 13·5 tons per day. In this case it was the same ship, boilers, propellers, and crew, and the same engines only altered in the way described. So far all the trials had been made with two-crank engines, so it was now decided to construct another set of engines for 150 lb. pressure, having a crank to each cylinder. These engines had cylinders 20½ in., 33 in., and 58 in. in diameter by 36 in. stroke, and were fitted into the screw steamer Rosario, whose dimensions are 275 ft. 3 in. between perpendiculars, 34 ft. 3 in. beam, and 19 ft. 2 in. depth of hold, 1,862 tons gross, and the dead weight capacity 2,550 tons. In March last year she was loaded with 2,530 tons dead weight, and made the voyage to Bombay at an average speed of 8·6 knots on a consumption of 10·5 tons per day of South Yorkshire coal, or 347 tons on the voyage. This result is superior to that of the Draco when the size of the ship is taken into account, but not so much so as might have been anticipated from the increase of pressure and the rate of expansion, which was 14·4 in the Rosario and 12 in the Draco.

Another set of engines was made from the patterns of those of the Draco, but with the high pressure cylinder 20 in. in diameter; steam at 150 lb. pressure being supplied from two single-ended boilers, having a total heating surface of 2,200 square feet. They were fitted in the S.S. Finland, a cargo boat 270 ft. long, 35 ft. beam, by 18 ft. depth of hold, and 1,954 tons gross register. In January she was loaded with 2,500 tons dead weight, and sailed for Rangoon. The average speed attained was 8·42 knots per hour, or 202 miles per day, on a consumption of 10·3 tons of Welsh coal per day, the rate of expansion being 12. All these ships were fitted with steam steering gear, so that, in comparing these results with those of vessels not so fitted, an allowance should be made. The consumption of water per indicated horse power calculated from the high pressure indicator diagrams was 14·1 in the Draco, 13·2 in the Rosario, and 13·16 in the Finland, or taking the medium pressure diagrams it was 12·2, 13·0, and 11·95 respectively. Comparing two other ships with triple expansion engines, of about 600 indicated horse power, the water consumed in a three-crank engine was 12·93 lb. against 13·0 lb. in the two-crank engine, but the former drives its ship half a knot faster than the latter. Mr. Seaton has now quite given up the double crank in favor of three-crank engine, on account of the more even wear of the brasses with the latter, due to the impossibility of equally dividing the work.

The largest engines Earle's Company have yet made have been for the Martello, having cylinders 31 in., 50 in., and 82 in. in diameter by 57 in. stroke. They run at 60 revolutions, with 150 lb. pressure, and indicate at sea 2,400 horse power. The consumption of Yorkshire coal averages 37 tons per day.

ON THE GENERATION OF A VOLTAIC CURRENT BY A SULPHUR CELL WITH A SOLID ELECTROLYTE.*

By SHELFORD BIDWELL, M.A., LL.B.

SO far as I am aware, there has never yet been constructed a voltaic cell having a solid electrolyte which, at least at ordinary temperatures, would produce the smallest indication of a current in the most delicate galvanometer. Sir William Thomson has described † a cell consisting of a piece of flint glass between plates of zinc and copper. After the glass had been warmed to 50° C., the plates were found to give indications of the existence of an electromotive force when connected with an electrometer. Profs. Ayrton and Perry have made similar experiments, ‡ using paraffin wax, gutta percha, India rubber, and shellac. But it is needless to say that with electrolytes of such enormous resistance as these no current could be generated which could be detected in the ordinary way by any galvanometer, however sensitive.

The present paper contains an account of some experiments with cells in which the electrolytes consisted of sulphides of silver and copper between plates of the same metals. In nearly every case these arrangements were found to be capable of generating sensible currents, which sometimes, indeed, measured several thousand micro-amperes, and were capable of producing deflections in coarse galvanometers with pivoted needles. Some of the results obtained are curious, and even opposed to what might have been expected, but they will, in general, be given without any comment or attempted explanation. The copper and silver plates used were in every case 3 cm. square.

1. A cell was made by compressing a thin layer of powdered silver sulphide between plates of silver and copper. When connected with a shunted reflecting galvanometer, this cell produced a deflection indicating a current of about 30 micro-amperes. The direction of the current was from copper through sulphide to silver. On the following day, the circuit having been open in the mean time, the cell generated a current of only four micro-amperes. The copper plate was found to have acquired a purple color; the silver was untarnished.

2. The same cell was charged with equal parts of silver sulphide and sublimed sulphur mixed together. It now gave a current in the same direction of about 1·5 micro-amperes.

3. A layer of precipitated copper sulphide was placed between plates of copper and silver, which were squeezed together in a screw-press. When connected with the galvanometer (unshunted), this arrangement produced no deflection whatever.

4. The cell was recharged with a mixture of two parts of copper sulphide with one part of sulphur, and when connected with the galvanometer, it was found to give a very small current from *silver to copper*, indicated by a deflection of two or three scale divisions. The deflection was reversed as often as the connections with the binding screws of the cell were reversed, and the existence of a small electromotive force was undoubted. The internal resistance was 0·088 ohm.

5. Sufficient sulphur was added to the mixture to bring the resistance up to 2,700 ohms. The cell when remade produced a galvanometer deflection which was at first about 100 divisions (indicating a current of 0·8 micro-ampere), but soon increased somewhat irregularly to 250 divisions. The direction of the current was as before, from silver to copper through the cell.

6. A plate of copper was heated, and upon it was spread a mixture consisting of five parts of sulphur and one of copper sulphide. A plate of silver, previously heated, was laid upon the melted mixture, and the two plates pressed together. The thickness of the sulphur mixture between the plates was 0·3 mm. When this cell, after cooling, was connected with the galvanometer, the spot of light was at once deflected off the scale. Dr. Fleming was kind enough to make a very accurate measurement of its electromotive force by comparison with one of his standard Daniell cells. It was found to be 0·0712 volt, and its internal resistance was 6,537 ohms.

7. A similar cell was made with a mixture of equal parts of sulphur and copper sulphide. Its internal resistance was much lower, being only 13 ohms, but its electromotive force was also lower, being 0·007 volt. This result agrees with those of 3, 4, and 5, in showing that the electromotive force is diminished when the proportion of sulphide to sulphur is increased.

8. Another cell was made in the same manner as the two last described, but the sulphur was mixed with silver sulphide instead of with copper sulphide. This gave a strong current in the same direction as that produced when copper sulphide was used, and opposite to the direction of the current generated by the cells 1 and 2. This reversal of the current may be accounted for by the fact that copper sulphide is formed when the

* A paper read before Section B, British Association, Aberdeen meeting.

† *Proc. Roy. Soc.*, 1875, xxiii., p. 463.

‡ *Proc. Roy. Soc.*, March 21, 1878, p. 222.

melted mixture of sulphur and silver sulphide is brought into contact with the hot copper plate.

9. In order to ascertain whether sufficient sulphide to maintain a current could be formed entirely in this manner, pure sulphur was melted on a clean plate of copper, and, when just liquid, a warmed plate of silver was laid upon it, and pressed down by a weight until cold. The cell gave a strong current from silver through sulphur to copper.*

10. Thinking that the function of the free sulphur (without which, as has been seen, copper sulphide is incapable of generating a current) might be to form silver sulphide by contact with the silver plate, I constructed a cell as follows: A thin layer of copper sulphide was laid upon a plate of copper, a polished steel plate was laid upon the sulphide, and the whole was strongly compressed in a vise. The steel plate was then removed, and a thin layer of silver sulphide was spread upon the smooth surface of the copper sulphide. The cell was completed by pressing a silver plate upon the silver sulphide. It gave a current of 240 micro-amperes through an external resistance of 3·5 ohms, the direction through the cell being from silver to copper. This form of sulphide cell seems to be exactly analogous in its action to a Daniell cell, consisting of plates of zinc and copper in solutions of zinc sulphate and copper sulphate. The quantity of the copper sulphide would be gradually diminished, copper being deposited upon the copper plate, while the quantity of silver sulphide would continually increase with consumption of the silver plate.

A similarly constructed cell, with plates 2¼ in. by 2 in., gave a current of 2,500 micro-amperes through an external circuit of 0·5 ohm.

11. Certain indications led me to believe that the cell last mentioned was short-circuited, and it appeared possible that this might be due to the penetration of particles of copper sulphide through the silver sulphide. The silver plate was therefore removed from the cell, and after being brushed over with a weak solution of sulphur in bisulphide of carbon, it was heated over a gas flame, and soon became covered with a perfectly uniform and continuous coating of sulphide. The heating was continued until all the free sulphur was driven off. When the cell was remade with this prepared plate, it generated a current of 6,800 micro-amperes through an external circuit of 0·2 ohm. The cell was found able to produce deflections in a roughly made galvanometer with a pivoted needle. Its electromotive force was 0·05 volt, and its internal resistance, therefore, was about 7 ohms.

Experiments with other metals would probably lead to the construction of a sulphur cell of greater power than any of those described in this paper. Silver may, indeed, be the best or only possible metal for the positive plate, but it is by no means certain that the copper of the negative plate might not be advantageously replaced by some other metal.†

PALMIERI'S CONSTANT DRY PILE.

IN a recent article on the Vesuvius Observatory ‡ I spoke of Mr. Palmieri's dry pile, with the intention later on of furnishing some details as to its construction.

It has for a long time been recognized that the energy of dry piles depends much upon the hygrometric state of the atmosphere and the temperature. This inconvenience, which need not be taken into consideration in certain applications of secondary importance, such as the setting in motion of the toy rope dancers, etc., that figure in all treatises on experimental physics, constitutes a serious defect in applications of a purely scientific nature. As this kind of pile, owing to the construction of the Bohnenberger electrometer, has acquired a peculiar importance, it has become of interest to obtain models of as constant energy as possible. With such an object in view, Mr. Palmieri has succeeded in regulating the variations of the Zamboni pile in a very simple way. As well known, the paper and tinfoil disks in the styles of dry pile usually employed are superposed by hundreds in glass tubes, which are closed by metallic caps that form the poles. On account of this arrangement, it often happens that, as a consequence of the deposit of atmospheric vapor upon the outer surface of the tube, the polar tensions are in great measure neutralized.

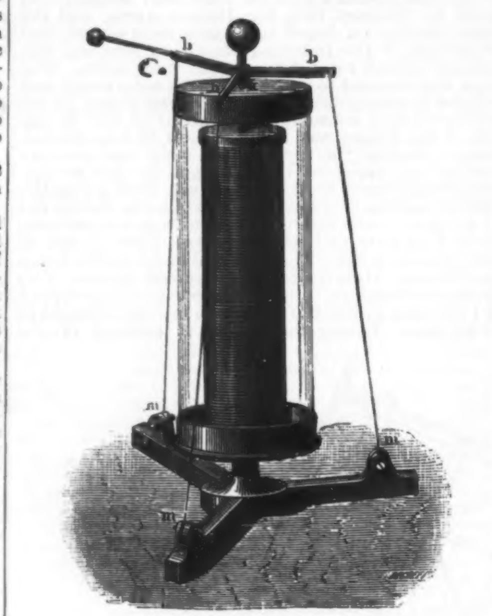
Mr. Palmieri, in the dry pile that he has devised, employs, as usual, a series of paper disks, covered on one side with tin foil and on the other with peroxide of manganese fixed with milk; but, instead of introducing these with slight friction into a glass tube, he superposes them according to the axis of a flint glass cylinder whose internal diameter exceeds that of the disks by several fractions of an inch. The result is that a cylindrical layer of air separates the pile from its protecting envelope, and no longer permits of a direct contact, that is to say, of an easy loss. The column of disks thus formed rests upon a piece of metal, and at its upper part is compressed by a copper disk held by a screw, K, whose nut is provided with three arms, *b, b, b*, to which are attached three silk threads that are fixed to as many pins, *m, m, m*.

Owing to this arrangement (which the annexed figure sufficiently explains), the pile, whose pressure can be regulated at will, preserves a remarkable constancy for years. It is scarcely necessary to dry the silk threads, even at long intervals.

In speaking of dry pile electroscopes, Pouillet says that these apparatus always seemed to him inconstant, because of the motions of the air in the glass, and the electrification of this air by the two poles. He relied upon the fact that the gold leaf at times takes on spontaneous motions, particularly when the apparatus chances to be exposed to the direct rays of the sun. But it is to be remarked that such effects occur even when the fixed conductor is touched with the finger, and that consequently we can scarcely allow that they are due to electrical tension.

Pouillet might have said as much of index electroscopes, since in this class of instruments the needle has many times been seen to oscillate spontaneously under the action of the solar rays, or when a lamp has been left near the apparatus for some little time. However this may be, Mr. Palmieri has judged it well to remedy the inconstancy of dry piles to as great a degree as possible, for the reason that they are very convenient instruments for ascertaining at the first glance whether the electricity under observation is positive or negative.

Dry piles assuredly weaken in time, but their duration is positively remarkable. One of the first that Zamboni constructed gave him evidences of activity for twenty-six years, and Mr. Palmieri has one in his possession (also of Zamboni's make) which, after a period of nearly fifty years, has not yet lost all its energy. These facts alone suffice to show that, however modest their role has remained up to the present,



PALMIERI'S DRY PILE.

dry piles perhaps are worthy of attracting the attention of electricians more seriously.—*P. Marcillac, in La Lumiere Electrique.*

INFLUENCE OF ELECTRICITY UPON A LIQUID FILM.

A FURTHER account of the experiments of Professors Reinold, F.R.S., and Rucker, F.R.S., as to the influence of an electric current in modifying the rate of thinning of a liquid film, has recently been published in the *Philosophical Magazine*. One of the primary objects of this investigation, of which a description was published in *Proceedings* of the Royal Society in 1877, was the determination of the electrical resistance of films. A Wheatstone bridge was employed for this purpose, and a current was passed through the film only at a moment when observation was required. It was then seen that the films became black, and measures of their resistance while displaying this color were successfully obtained. Afterward continuous currents were employed, and the difference of potential between two fine wires thrust into the film was measured by an electrometer, and compared with the resistance between two other points in the same circuit, separated by a known resistance. The results obtained was not altogether of a satisfactory nature; but the later experiments are interesting as showing the behavior of the films and the nature of the colors evolved under the influence of the electric current. The liquid employed consisted either of a solution of potash, soap in water, or of *liquide glycérique*, containing a certain portion of niter to increase its conductivity. The films had the form of vertical cylinders; the upper and lower ring supports being of platinum, and about 33 millimeters in diameter. The cylinders were, as a rule, from 30 to 40 millimeters in length, but occasionally other lengths were under examination. Three films were observed simultaneously, two of them being in one glass box, and the third in a separate glass box. The two that were together were supported by platinum rings identically alike, and sharply beveled at the edge; the edges of the supports of the third were much thicker, and were rounded. It could thus be ascertained whether any difference in the behavior of the films was due to the form or thickness of their supports. No such difference was observed. Each of the film boxes was placed in the center of a water tank with glass sides, in order to prevent rapid changes of temperature. In all cases the films were surrounded with air saturated with the vapor of the liquid of which they were made. The constancy of the hygrometric state of the air and that of its temperature were indicated respectively by a hair hygrometer and a thermometer inside the glass case. The films were blown with air, which was first dried and then passed over some of the soap solution in a wide tube. The state of the air inside the film was thus approximately the same as that on the outside. The current employed was generated by a Siemens dynamo, and passed through a sensitive reflecting galvanometer, the deflection on the scale measuring approximately the strength of the current. This varied from about 100 micro-amperes to 0·5 of a micro-ampere. Under these conditions it was seen that in less than a minute after the adjustment of the film (potash-soap solution, without glycerine, 40 millimeters) to the cylindrical form, narrow rings of color appeared, and white of the first order of Newton's rings was soon seen at the top, generally bordered by a deep band of blue of the second order. The colored portion of the film extended only 10 millimeters from the top. In from eight to fifteen minutes from the moment of formation of the film, a black film appeared, and slowly extended downward. The behavior of the films under the influence of the current was now observed. With a solution of potash-soap and a film 40 millimeters long, through which the current was passed from the moment of its formation, it was found that broad bands of color formed and spread with great rapidity, soon occupying the whole area of the film. After six minutes the current was 2·6 micro-amperes. In eleven minutes there was a ring of black, which increased in three minutes to 3 millimeters. Next, a film of 40 millimeters was taken, which had thinned until 2·5 millimeters of black were formed. Following the black was a band of deep blue. A downward current of 5·18 micro-amperes was applied. The blue changed to white, the black not being altered. After nine minutes the black was still of the same breadth, and the white had increased to 16 millimeters, the current being 4·06 micro-amperes. In two minutes after breaking the circuit the white had changed to black, the extent of which had become 19 millimeters, or nearly the whole length of the film. This and similar observations showed that a downward current had the remarkable effect of swiftly thinning that part of the film which was thicker than the black, but did not necessarily affect the latter. The film, however, was put into such a state that, on the cessation of the current, the development of the black proceeded at a rapid rate. With a downward current of 6·2 micro-amperes the black entirely disappeared after one minute, being replaced by white; and the current rose to 6·5 micro-amperes. The latter had the effect of destroying the black and increasing the conductivity of the film. With a film 30 millimeters long, to which a downward current of 24 micro-amperes was applied from the beginning, the white extended more than half way down, after ten minutes, and the current fell to 2·5 micro-amperes. The circuit was then broken, and the white turned to black so rapidly that the entire transformation was effected in less than one minute. Under the influence of the upward current the black was always destroyed, and, where previously existing, replaced by white; the current generally increased in intensity up to a certain limit. At certain stages of the film's existence a very feeble current was sufficient to destroy the black. One very interesting experiment was performed upon two films, each 30 millimeters long, which were formed side by side. The current was divided, and passed up one and down the other film. The effect was most striking. In twelve minutes, when one of the films broke, there were 15 millimeters of black in the one, while the other was thick and colorless, and liquid was streaming from the top of it.

ST. MARY'S (R. C.) CHURCH, LEEK, STAFFORDSHIRE.

WE give on page 8291 views of the design for the above church, prepared by Mr. Albert Vicars, Somerset Chambers, 151 Strand, London, for the Rev. Alfred M. Sperling. The foundation stone was laid on the 15th inst. by the Right Rev. Edward Ilsley, D.D., Bishop Auxiliary of Birmingham. The edifice is already erected some feet higher than the church floor level, which is about 10 ft. above the street, and will be in the decorated style of architecture. The plan consists of nave and two aisles, chancel (arranged for surpliced choir), two side chapels, baptistery, confessional, recessed in wall of aisle, opening into a small room, for priests, fitted with a fireplace; nuns' choir for the use of the adjoining convent; priest's sacristy, with heating chamber under; and working sacristy, surmounted by a very effective tower and spire 140 ft. high. The organ gallery is at the west end; the chancel and side chapels at the west end. The interior length of the chapel is 104 ft. long by 50 ft. wide, and the height to the apex of the barrel roof ceiling of the nave and chancel will be 53 ft. 6 in. The exterior elevation of the roof from floor to ridge is to be 64 ft. The columns and responds of nave and chancel arcading, the shafts supporting principals of roof, also the exterior shafts, columns, and bands on spire, will be of red Scotch stone. The rock-faced ashlar is to be of local Hazelhurst stone, and the dressings of Doulting stone. Messrs. Barker & Son, of Birmingham, are the contractors, and Mr. Peter Shaw the clerk of works.—*Building News.*

DUCHESS'S BEDROOM.

DERWENT Hall, belonging to the Duke of Norfolk, is situated near Sheffield, and the work a few years ago carried out there was done under the direction of Mr. J. F. Hansom, the architect. Our present sketch, on page 8291, shows the apartment known as the "Duchess's Bedroom," celebrated for its magnificent bedstead of elaborated Jacobean workmanship, while the other furniture of the room is also very good in style and equally interesting.

This bed, however, is an uncommonly fine one, more particularly on account of its beautiful detached posts or columns supporting the very rich canopy or tester. The foot-board, too, is specially refined and elegant in the detail of its ornamentation, almost Italian in some of its carvings. The well-known beds at the King's Arms Tavern, Lancaster (figured in the "John o' Gaunt Sketch-Book"), are in some ways like it; and in connection with them are the bedsteads still to be seen at Hampton Court, Hatfield and Hardwick Halls, as well as at Wroxton Abbey, Oxfordshire. Abroad, instances crowd on the memory of high beds and wonderfully carved bedsteads, particularly those of the time of Francis I. Several have caryatides for posts, as in the bedroom of Diana de Poictiers at Chenonceaux, where the bedstead has a solid box carved plinth on all sides; and at the foot, over the cornice and draped frieze, occurs a rather curiously treated semicircular pediment quite in character with the style. At Azay le Rideau is another bed of the same type, but more elaborate and less admirable. These both contrast more favorably with each other than they do with our present Old English piece of work from Yorkshire, which, though so rich in style, has a quiet, homely dignity about it. In the center of the ceiling is a pendant enriched with

* A thin layer of sublimed sulphur was compressed between *cold* plates of silver and copper, which were connected with the galvanometer. A deflection of three divisions was produced, indicating a minute current from silver to copper. The experiment was repeated several times with the same result. (Moisture in the sulphur would have caused a current in the opposite direction.) This effect can, I think, only be explained by supposing that sulphides were formed in small quantities and diffused through the sulphur; but little importance can at present be attached to it.

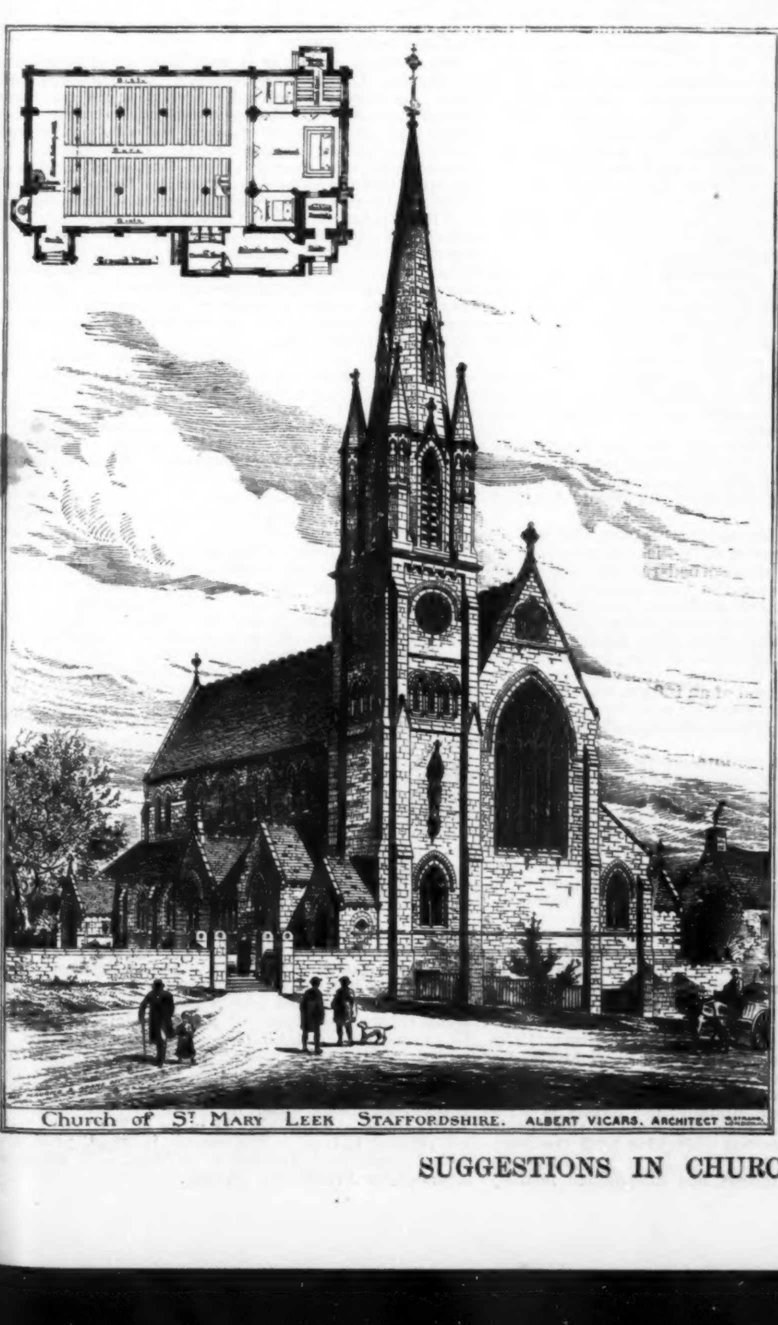
† In a paper recently communicated to the Physical Society, which will be published in its *Proceedings* and also in the *Phil. Mag.*, experiments are quoted showing that the action of light *diminishes* the current generated by these sulphide cells, while heat increases it. Some very curious polarization effects are also described.

‡ SUPPLEMENT, p. 8178.

THE DUCHESS'S BEDROOM.

brackets and fleur de lis, while in the middle of the bed's head over the arched paneling occurs a ducal coronet, shaped something like a miter, above a heraldic shield and ribbon. The ceiling is coffered, and the frieze has grotesque beasts carved upon it, rather later, probably, in date than the constructive parts.

Our drawing of the Derwent Hall Bed is based upon a photograph. The illustration also shows the old folding table and carved chairs, together with the elaborately inlaid wardrobe which stands next the bed.—*Building News.*


Church of St. Mary Leek Staffordshire. Albert Vicars, Architect

SUGGESTIONS IN CHURCH ARCHITECTURE.

THE CLIMATIC INFLUENCE OF FORESTS.

LUCIEN CHANCERAL, of the Forestry School of Nancy, contributes a lengthy article to *Le Genie Civile*, of April 25, upon the climatic influence of the forests of Algiers, and their relation to colonization, practically as follows:

I. *The influence of forests upon the production and frequency of rains.*—Hutton explains the formation of rain by the intermingling of two volumes of air at different temperatures; the density of saturation of the watery vapor increases more rapidly than the temperature itself, and condensation takes place, accordingly as the two volumes of air are or are not saturated with moisture.

Babinet gives another explanation: when a volume of air charged with watery vapor meets an obstacle, it is forcibly lifted up and expands, the temperature is thus lowered, and the condensation of the vapor follows in the form of rain. This is what M. De Lapparant means when he says that "obstacles placed in the path of a current of humid air mechanically extract the moisture from the vapor as pressure causes water to leave a sponge."

Rains are more frequent in mountainous countries than in the plains; and this phenomenon is especially remarked in the valleys lying at the foot of high mountain chains exposed to currents charged with moisture, as in the regions west of the Cordilleras and Andes, and south of the Himalaya mountains; at the foot of the last named range the warm winds of the tropics deposit a rainfall of about 48½ *feet* per annum.

These two explanations of rainfall are both admissible; the phenomenon is as much the result of one of these actions as it is of the other, and frequently the two are combined.

It is easy to demonstrate, in the two cases, the influence of the forests upon rainfall. These forests act in the beginning as the sources of a temperature differing from that of the mean air, and experiment has proved that this temperature, under the trees and outside the wooded space, is never identical; at a height of about 5 feet above the ground, the mean annual temperature is about 0·75° C. lower under the trees than outside, as observed at the German forestry stations. A forest may, then, be considered as representing a mass of air of a temperature differing from the general atmosphere, and usually lower; this air effects by its radiation all that is in its neighborhood, and plays a *role* to which sufficient importance has not yet been accorded. The volume of this mass of air would be obtained by multiplying its surface by the height of the tree trunks; it would act by contact and radiation, not only upon the near strata of air, but also upon those which are brought to it by the aerial currents; for there are currents at all times, as absolute rest is an impossibility, even though the best anemometer fails to indicate it. And in this forest the difference in range of temperature with the outer air will vary with the density of the mass.

In the second place, forests act as *physical obstacles.* They force upward the mass of air charged with water, which then expands, becomes chilled, and condensation follows. The loss of living force due to the shock of contact, and the equivalent production of heat, is only exceptional, and is so limited in its action that it will not compensate for the other phenomenon. Furthermore, the temperature diminishes with the pressure, according to a law which is constant, to a height of about 10,000 feet; and the simple fact of forcing the mass of humid air into the more elevated regions is sufficient in itself to produce rain. Although the action of forests considered as material obstacles may be feeble, nevertheless, their influence cannot be neglected.

Considered again as a physical obstacle, a woods would mechanically stop or retard an air current striking it at any angle; it would have the same influence upon it that any roughened surface would have upon an easily moving mass passing over it. It is well known that in a cloud, or in a volume of humid air forming a fog, the water is found in the state of fine particles held in suspension; in a vesicular form, in fact. These minute drops are arrested, in part, by the wooded surface, the speed of the cloud is slackened, and its temperature passes through the change in degree which makes a shower possible.

From what we have said it follows that the more the forest is made up of high trees, the better it ought to condense the watery vapor; in fact, experiment proves that the rain is heavier in a forest than on a surface covered simply by low bushes. The greater the extent of a woods, the more rain it should provoke; and again, all other circumstances being equal, the most densely wooded countries are those where rain is most abundant and frequent.

But in reality this phenomenon of rain is extremely complex, and is influenced by the varying circumstances of temperature, pressure, altitude, season, the sun's rays, and the latitude. The one fact derived from the experiments mentioned, as being made at the German forestry stations, is that it rains more frequently and abundantly in a wooded region than in the non-wooded; and we can affirm, without fear of denial, that the colonies will have sufficient and regular rains as soon as the actual coefficient of woodland in Algeria is no longer the feeble quantity which it is to-day. In these colonies this coefficient should be in direct proportion to the mean annual temperature, and the effort should be made to carry out this law, especially in North Africa, where the density of the atmospheric vapor is very feeble, rarely exceeding 10 to 15 millimeters of mercury.

The influence of forests upon the regimen of rivers.—The rain-water which falls upon the earth is divided into three parts: One portion is subjected to the action of evaporation; another part filters into the earth to feed the springs and subterranean water courses; and a third still ripples over the surface of the soil as a direct tributary to the water courses.

We will first study the influence of forests upon evaporation. The quantity of water evaporated from different soils varies with their mineralogical, physical, and chemical nature. Leaving out of consideration these physical circumstances, the coefficient of evaporation from the soil increases as the temperature becomes higher, and in Algeria the evaporation would naturally be more considerable than in France. We can comprehend that the forests, by their foliage, and by the *debris* and carpeting of dead leaves on the ground, would diminish evaporation in a notable degree. It may be objected that the foliage of trees multiplies the surfaces of evaporation, and as a consequence favors it; but it is easy to realize that this factor is small as compared with the first named; and, moreover, while the one can only operate during the time of the shower itself, the other is constant in its influence.

The influence of forests upon the infiltration and the surface streams of water is also worthy of consideration. By the covering of dead leaves and the vegetable mould which they produce, the forests regulate infiltration, and following the innumerable roots which pierce the soil, the water is enabled to gain the deeper strata, and often penetrate otherwise impermeable material. The water, in fact, which soaks into the soil, and follows the roots of the vegetable growth and the interstices of the rock, is first absorbed by the surface mould of the undergrowth, and it only leaves this after saturation, which follows determined laws.

In regard to the power of absorbing water possessed by dense forests, we would remark that all forest soil is composed theoretically of the following elements:

1. The *covering*, which is made up by the vegetable *debris* falling upon the ground.
2. The *mould*, formed by the decomposition of the covering.
3. The *vegetable earth*, so called, which is composed of the mineral *debris* of the rocks, the mineralogical base, mixed with the mould.
4. The *mineral earth*, mostly made up of the rocky *debris*.
5. The *living rock*, that which determines the nature of the soil, and under it the various mineralogical strata.

The two first named elements are the most important for their power of absorption of which we speak. Eber-Mayer has found that in a forest the mean vegetable production was in round numbers 6,000 kilos. per *hectare* (about 5,344 lb. per acre) annually; the vegetable *debris* constituting one-half of this quantity. It is not then absurd to suppose that in a forest normally situated the bed of vegetable mould might reach a thickness of 2 to 4 inches; or at least, that as far as the absorption of water is concerned by the forest soil, the conditions are the same as if this were so. It is then easy to deduce by the absorbent power of this forest soil the quantity of water which it might store, ready to give it out gradually to the colony, and that at the moment when it has the greatest need for it, that is to say, during the dry season.

The forest mould, according to M. Deherain, contains for each *liter* 0·935 kilo. of water and 0·493 kilo. of earth; then for a bed of mould equal to 0·05 m. in thickness, each square meter would contain 50 liters or 47·75 kilos. of water and 24·65 kilos. of earth, and one hectare of this soil would confine 478 cubic meters of water. If the 2,000,000 hectares of woodland in Algeria constituted a normal forest, they would then store up 956,000,000 cubic meters of water; or for a bed of mould 0·10 m. deep, a quantity nearly equal to 2,000 million cubic meters.

It is interesting to study in this connection the value of forests as storage reservoirs, and calculate how many reservoirs, like that of Hamiz for example, would be required to hold a volume of water such as we have mentioned above. The Hamiz reservoir, when full, contains from 14,000,000 to 15,000,000 cubic meters; and dividing this into the first amount given above, we find that 66 reservoirs of that size would be needed to hold the water stored in 0·05 meter of forest mould.

Greater results still are obtained by taking into the calculation the other portions of the forest soil, and especially the surface *debris*. Eber-Mayer compares this covering to a sponge, which retains by imbibition and by capillary action an enormous quantity of water; the leaves falling annually are able to absorb from 5 to 13 cubic meters of rain water per hectare.

Without for a moment contesting the immense and immediate utility of reservoirs, we would still wish to demonstrate that forests, judiciously distributed, have also a remarkable value, especially in Algeria, where water means the prosperity of the colony. By their surface *debris*, forests provide a screen opposed to evaporation, and favor the decomposition of the rocks; by this *debris* and the mould beneath, they cover the soil with a porous, permeable surface, comparable to an immense bed of sponges.

If we now study the effect upon the running streams, or rather that portion of the rainfall which escapes over the surface to feed the streams, we will see that the forest elements of which we speak should diminish and regulate this flow.

The coefficient of water passing off over the surface of the soil, in any given country, is the relation between the quantity of unabsorbed rainfall passing directly to the streams and the total quantity of water falling in that region; this coefficient is very variable, depending as before upon the mineralogical, physical, and chemical composition of the soil. In the Alps, this portion of the rainfall gives rise to the phenomenon of torrents. Quoting M. Cezanne, "the violence of torrents is an integral formed of an infinite number of imperceptible elements; the system of extinction consists in destroying separately each of these elements without neglecting any."

It is clear that if the mountain tops stand for a long time denuded of timber and exposed to all the erosive action of rain, they will be finally reduced to a rocky skeleton, upon which any retimbering process would become extremely difficult. It is on a surface such as this that torrents gather their forces, thanks to the greater volume of rainfall passing freely *over* the surface and following the depressions; put timber in this basin of reception, and you will arrest the torrential action.

Numerous geographical citations can be made in support of the theories advanced. Algiers itself is a proof in point, for it was at one time wooded, and of water there was no lack. But now many of the old water courses are dry, thanks to the forest denudation; and the phenomenon is general over the whole north coast of Africa, in Tripoli, Tunis, and Morocco. Palestine and Libya, once so fertile, have been deprived of the woods and, as a consequence, of water and vegetation. In the Madeira and Canary Islands, and in the Azores, rain was once abundant; the forests have disappeared, and it is now rare. In some of the Antilles the diminution of rain has coincided with the disappearance of the woodlands; while in Porto Rico the preservation of the forests has maintained fertility. At the Cape of Good Hope, at Georgetown, a sad change in the climate has occurred from this same cause.

In fact, the following general law can be formulated: In every country where special cause for the natural humidity of the atmosphere does not exist, causes such as are found in the regions on the west coast of South America, the Atlantic coast of Central America, the Brazilian coast, and the country south of the Himalayas, in every land where the proportion of watery vapor in the atmosphere is light, the maintenance of wooded districts is absolutely necessary from a climatic point of view; and it is the more indispensable as the watery vapor in the air is the least and the temperature the highest.

Then, too, wood itself is a factor only second in value to water to the colonist in Algiers. It is a product everywhere growing scarcer, and to-day in France, Italy, Spain, and England the importations of wood notably exceed the export, and its intrinsic value is steadily increasing. The soil of Algiers is capable of producing fine timber; for that which does grow there has all the desirable properties of density, hardness, elasticity, and durability, in air and water. But to reproduce forests of like timber would be now a long and costly operation. But among the trees that would grow in the new soil of Algiers with the greatest rapidity, we can cite the *Eucalyptus globulus*, now well known. The fact is well established that this tree will grow with a prodigious vegetable activity in a new soil of medium fertility. Under these conditions we have found that its mean annual increase, for a growth of fifteen years, was about 15 cubic meters per hectare; in other words, that the woody material upon a hectare of eucalyptus was, at the end of fifteen years, $15 \times 15 = 225$ cubic meters. And fixing the value of a cubic meter at 10 francs, there would be found, at the end of fifteen years, 2,250 francs per hectare of timber, or in a well managed forest an annual valuation of 150 francs per hectare.

In the shape of saplings, the eucalyptus can be used at once for any minor carpentry; but it is first necessary to submit it to a slow and progressive drying. For to form its tissues so rapidly, this tree must absorb at the same time a great quantity of carbon through its leaves and much water by its roots. It is this double faculty of rapidly absorbing both carbon and water that explains in part its health-giving qualities.

Some other influences of forests.—Having shown how heavily wooded tracts contribute to the water supply of and furnish timber to the colonists, we will pass rapidly over other services still which they are capable of rendering, from a colonial point of view.

Timbered land would stop the formation of the sand dunes which are now making a sensible progress over almost the entire extent of the north African coast. It would protect cultivation against the wind currents from the sea. And forests, by protecting the soil from the direct rays of the sun, would also materially check the phenomenon called the sirocco. In this connection, Becquerel has remarked that if the Sahara was covered with timber, the sirocco would be suppressed, for he regarded this frightful air-current as being entirely due to the heating of the desert soil. Grisbach, however, explains the sirocco as being a counter current from the trade winds.

But as the tendency is to attribute all atmospheric movements to mechanical causes, the theory of M. Faye is generally admitted. According to this last-named authority, great movements in air masses take their origin in the upper strata of the atmosphere, and not at the surface of the ground; there are, in fact, true atmospheric tides produced by the attraction of the stars and the moon in particular. These air masses in moving turn about a vertical axis, and this vertical axis itself is moved in a line parallel to itself; it follows a trajectory which is a parabola with the opening toward the east. The masses of air in their violent revolution assume a funnel-shape with the point toward the earth, and the living force produced by this gyratory motion, at the moment of contact with the surface of the earth, gives rise to the phenomenon of storms and hurricanes.

The theory explains, in part, the great atmospheric movements. But does it prove that all movement in the air masses and watery vapors comes only from the higher regions? Does it prove that the theory of aspiration, or exhaustion, by which, before the day of M. Faye, it was attempted to explain atmospheric movement, is completely erroneous? While we recognize the exactitude of the new theory, it does seem that the old theory is capable of existing side by side with it, and explaining still certain movements in the air currents which are being continually produced. From the standpoint of the older theory, no one can contest the influence which a soil covered by forests would have in protecting this soil from being rapidly heated by the sun's rays. And supposing that the sirocco was produced only by mechanical causes, if a massive woods would not suppress it, it would still do much toward lessening its evil action.

From a sanitary point of view, forests have an electrical action favorable to sanitation; directly they give health to a country by taking up the azote of the ammoniacal compounds, in seizing the carbon in the carbonic acid and restoring the oxygen, in sifting out the humid air charged with miasmatic vapors, all to such a degree that the people living under the trees are better preserved, as is proved in the Pontine marshes. We would not say that the sanitary influence of forests is illimitable, for it is evident that their action would be very feeble opposed to the endemics peculiar to the intertropical countries, where the humidity and heat are united and powerful in action to an extreme degree.—*Engineering News.*

THE solidification of lavas and metals displays complicated phenomena which have given scope to various misinterpretations. Silicates (lavas and glasses) generally solidify in a vitreous form in the dry heat of a furnace. If the congealed mass remains for a long time at a temperature close upon the melting-point, approaches to crystallization take place, and are promoted by moisture. If glass is embedded, at a high temperature, in gypsum or other substances which give off water, the mass becomes crystalline. Lava as it bursts forth is permeated with water, or, more properly speaking, with saturated solutions. If large quantities of water are present in lava, it evaporates in part, producing tumefaction and dissipation in dust.—*E. Reyer, in Journal fur Praktische Chemie.*

NEW PROCESS OF LIQUEFYING OXYGEN.*

LIQUID ethylene, the preparation and use of which I have already explained, shows, at its boiling point under the pressure of the atmosphere, a temperature of at least −103° C., only some 10° from the critical temperature of oxygen (−113° C.). It is understood how, in the expansion of compressed and cooled oxygen in the boiling ethylene, the lowering of the temperature resulting from the expansion enabled me to establish "a tumultuous ebullition continuing an appreciable time." In regulating the expansion so as to maintain a certain pressure in the tube, the oxygen is seen for some time completely liquefied.

When by means of the air-pump the evaporation of

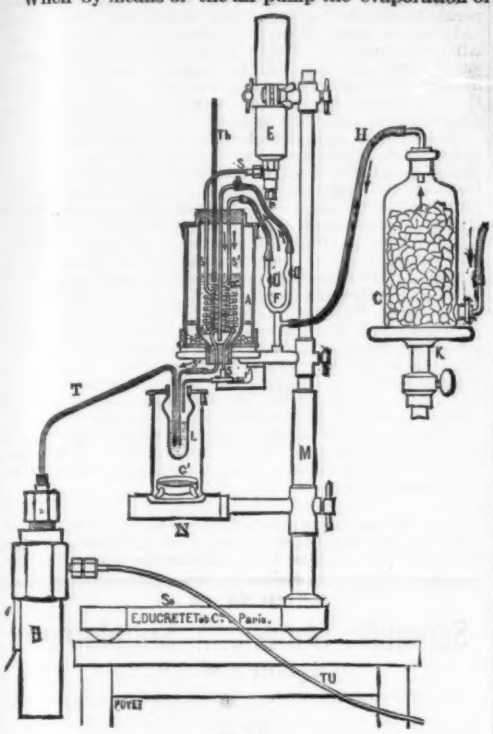


FIG. 1.

liquid ethylene is accelerated, as was done by Faraday with protoxide of nitrogen and carbonic acid, its temperature is reduced much below the critical point of oxygen.

With a view to avoiding the inconveniences and complications involved in the necessity of working *in vacuo*, I indicated liquid *formene*, which with the greatest ease achieves the liquefaction of oxygen and nitrogen. Notwithstanding these advantages, in consequence of the perfection to which I have recently brought the preparation and management of ethylene, it has seemed to me that this substance should be preferred to formene, and so, by means of boiling ethylene in open vessels, I have succeeded in obtaining a temperature sufficiently low for the complete liquefaction of oxygen.

The preparation of ethylene by means of sulphuric acid and alcohol is frequently impeded by the frothing of the material terminating the experiment before the gas has been completely liberated. The admixture of sand, recommended by Wohler, does not always serve to counteract this frothing, but I have found the addition of a small quantity of vaseline efficacious in this respect.

The material I work with consists of 400 grammes of alcohol, 2,000 grammes of sulphuric acid, and 15 to 20 grammes of vaseline. This is warmed in a glass globe, of 5 or 6 liters capacity, over a burner in the usual way. The gas is washed in two large flasks of caustic soda, and then collected in a water-gas holder. By means of

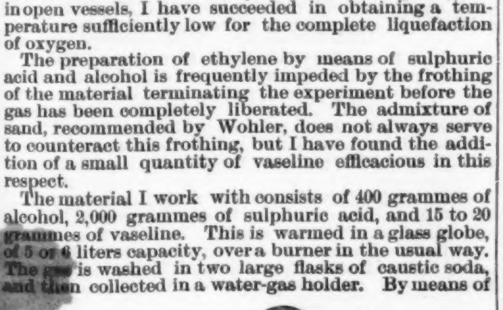


FIG. 2.

a mercury pump the ethylene is dried by passing through a flask of sulphuric acid, and condensed in steel bottles having a screw tap.

Fig. 1 represents the apparatus I made use of to liquefy oxygen by the rapid evaporation of ethylene by means of a current of air or of refrigerated hydrogen. The liquid ethylene is inclosed in the bottle, E, which is fixed to a vertical support, with its mouth directed downward, and is in communication with a copper worm, SS, of 3 mm. to 4 mm. in diameter, closed at its lower extremity by a screw cock, r'. After the worm has been cooled to −70° by means of chloride of methylene in the manner I shall explain further on, the ethylene there accumulating possesses at this temperature but a week tension, and it may therefore be run without sensible loss into the test-tube, L, when the cock, r', is opened. This new arrangement I have adopted for ethylene and formene allows the liquefied gas to be cooled as well as though the whole reservoir containing it were of the same temperature as the worm.

The glass test-tube, L, is arranged in a vessel containing air dried by means of pumice and sulphuric, G,' and in this way hoar-frost is prevented from being deposited on the refrigerated sides.

When the ethylene has been received in the test-tube, L, its evaporation is accelerated by passing through it a current of air, or, still better, of hydrogen dried by its passage in the vessel, C, containing chloride of calcium, and cooled in the worm, S'.

The two worms in which the air and the ethylene circulate are plunged into chloride of methylene, which is rapidly evaporated by means of dry and cool air, and in this way a temperature of −70° is obtained.

Fig. 2 shows the arrangement of the oxygen apparatus and the compression pump. When the tube, To, is plunged into the ethylene, the evaporation of the latter is accelerated by gently opening the cock, F, and blowing on to it the air or hydrogen cooled in the worm, S'.

The pump is then brought into action, and the oxygen resolves into a colorless, transparent liquid, separated from the gas surmounting it by a perfectly sharp meniscus.

By means of a hydrogen thermometer, the construction of which I shall shortly explain, I have measured the temperature of the ethylene, which in one of my experiments was found to be −123° C. By dint of certain modifications effected in the apparatus, I am in hopes of achieving a still lower temperature.

Altogether, I have proved that by quickening the evaporation of the ethylene by means of a current of air or hydrogen cooled to a low degree, its temperature is lowered much under that of the critical point of oxygen, and that in such a medium the oxygen liquefies most easily.*

This experiment is so easy of accomplishment that the practice of it may be commenced at once in laboratories, and be repeated in public lectures.

The apparatus I have described has been constructed with great care by M. Ducretet, and I have to thank M. Jamin for kindly permitting me to perform the experiments in the Physical Laboratory of the Sorbonne.

* From the *Journal de Physique*, by M. L. Cailletet. From *Nature*.

* M. R. Sainte-Claire Deville, engineer to the Gas Company of Paris, and son of my illustrious master, has now for some time, by my advice, been studying the problem of lowering the temperature by means of the rapid evaporation of chloride of methylene, and has established that, by sufficiently cooling the injected air, temperatures varying from −33° C. to −72° C. may be maintained nearly constant for several hours.

CLEMATIS DAVIDIANA.

THIS is one of the annual species introduced from Northern China by the Abbe David, and appropriately named after him by the late M. Decaisne. For the specimen whence our illustration was taken, we are indebted to Mr. Lynch, of the Cambridge Botanic Garden, and a comparison of the figure now given with that in M. Decaisne's memoir on the tubular flowered clematis will show how greatly the plant has advanced in the matter of attractiveness. The flowers are of a rich blue color, with a powerful perfume, as in Clematis flammula, and so far seem to have produced stamens only. M. Decaisne mentions that the dried specimens in herbaria are likewise male. The plant dries down in winter, but the stock is quite hardy, so that we have in it a notable addition to our collection of herbaceous plants. A full description is given in M. Decaisne's monograph in the *Nouvelle Archives du Museum* and in the *Flore des Serres*, vol. xxii., p. 163. For the rest, our illustration tells its own tale.—*The Gardeners' Chronicle.*

CLEMATIS DAVIDIANA: HARDY ERECT HERBACEOUS PLANT: FLOWERS BLUE.

FRENCH METHOD OF EXTERMINATING THE PHYLLOXERA.

IN July last, that terrible pest, the phylloxera, was discovered in the vineyards of Mansourah, in the province of Oran, Algeria. From minute and methodical researches, made at once under the direction of special agents sent in haste by the Minister of Agriculture, it was found that the trouble extended over an area of thirteen acres, in disseminated patches, and it was likewise ascertained that the infection was the result of a fraudulent conveyance of plants from infected districts in France three or four years ago. Very fortunately, the administration, foreseeing the possibility of such an introduction into Algeria, had got the Chambers to adopt the law of the 21st of March, 1885, giving it very wide power in the matter of the destruction of the phylloxera in our fine colony. So the service that was organized was enabled to at once take most vigorous measures to destroy the infected vineyards, which it immediately surrounded with a cordon of soldiers, who had orders to allow no one to pass except those employed in the work of destruction. In these sorts of treatments the object to be attained is the complete annihilation of all the aerial and subterranean parts of the vine, in order to be certain of having killed all the phylloxeras. The work of cutting up and burning the vines, in which the soldiers aided, was proceeded with without delay—the destruction by fire being followed by drenching the stumps with petroleum (Fig. 1). As some larvæ had already been observed at the time of the first excavations, it became necessary to take measures at once against one danger—that to which the vines of the vicinity were exposed through

a swarming of the insects, which, although it had not as yet begun, was imminent.

The sulphide of carbon had not yet arrived, and there was reason for prompt action. By pouring about nine ounces of petroleum along side of the decapitated trunks, and more than this in the case of large stumps, the subterranean portion of the trunks, as far as to the main roots, was saturated, as was also the surrounding earth (Fig. 2). This operation, which had the effect of cutting off the natural route that the pupæ take in order to become transformed into migrating, winged insects, was renewed as many as three times in order to keep up a constant saturation until the arrival of the sulphide. By soundings made after each of these applications of petroleum, it was found that there had been a radical destruction of the insects as far as to a depth of, say, one inch, while below that the phylloxeras possessed their usual aspect and vitality. Although it did not seem probable that the insects could make their exit from the surface, it was judged well to render the ground compact by means of rammers, in order to make the success of the work certain.

Ater this came the treatment with sulphide of carbon. This consisted in making, by means of graduated injecting apparatus, two successive applications of the sulphide in the proportion of one and a quarter drachms to the square foot or two and a half drachms per square foot for the two operations, performed three or four days apart. The one and a quarter drachms was divided up between a certain number of holes to the square foot. Some of these holes were formed at the very base of the stumps, and were injected with one and a quarter ounces of the sulphide, in order to better secure a radical destruction of the stumps. The number of the injections and the two applications permitted of a more equal diffusion of the insecticide, and of preventing those failures and errors that are possible where manual labor is concerned. The quantity of sulphide used per acre was 3,960 pounds, and this was distributed among 180,000 holes.

This sulphide treatment was effected at a high temperature and in extremely dry (sometimes very hard) soil, which was of an argillaceo-ferruginous nature. All the roadways, as well as the borders of the vineyards, were treated with very heavy doses, and it was necessary to have recourse to sledge hammers to drive the apparatus into the earth (Fig. 4). The same difficulties were met with in a number of vineyards.

These operations, which were begun on the 9th of July, were finished on the 11th of August. The destruction of the fruit trees which stood on the land treated, but which received no application of the sulphide, allowed the work of destruction accomplished on the subterranean part of the vines to be judged of. At the present time, the mulberry, fig, orange, olive, and cherry trees in the vineyards treated are dead. A few days after the treatment their branches withered, and their leaves dried and fell off.

As stated above, the presence of larvæ was observed at the time of the first researches. For the purpose of guarding against the partial swarming that may have occurred before the treatment was begun, the administration intends to take the following measures of precaution: (1) to order the burning *in situ* of all branches, debris of cuttings, etc., in all the vineyards of the section of Mansourah; (2) in the vineyards of this same section, to have an application of Mr. Balbiani's mixture made to the winter egg of the phylloxera.—*La Nature.*

FIG. 1.—CUTTING DOWN AND BURNING VINES INFESTED WITH PHYLLOXERA.

FIG. 2.—TREATING STUMPS WITH PETROLEUM.

FIG. 3.—RAMMING THE EARTH.

FIG. 4.—TREATMENT WITH SULPHIDE OF CARBON.

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